JUNE 1972 60 CENTS

Popular Science

THE What's New MAGAZINE

THE NEW ESV's
Cars That Will Let You Walk Away from "Fatal" Crashes

For Exciting New Sport
THE HANG GLIDER
Fly It, You'll Like It!

PLATE TECTONICS
New Science of the Earth Explains Old Mysteries

MUSIC IN YOUR CAR
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BUCKY FULLER'S HEXA-PENT
Domehome You Can Build

NEW FAIL-SAFE TIRE
Lets You Drive on a Flat

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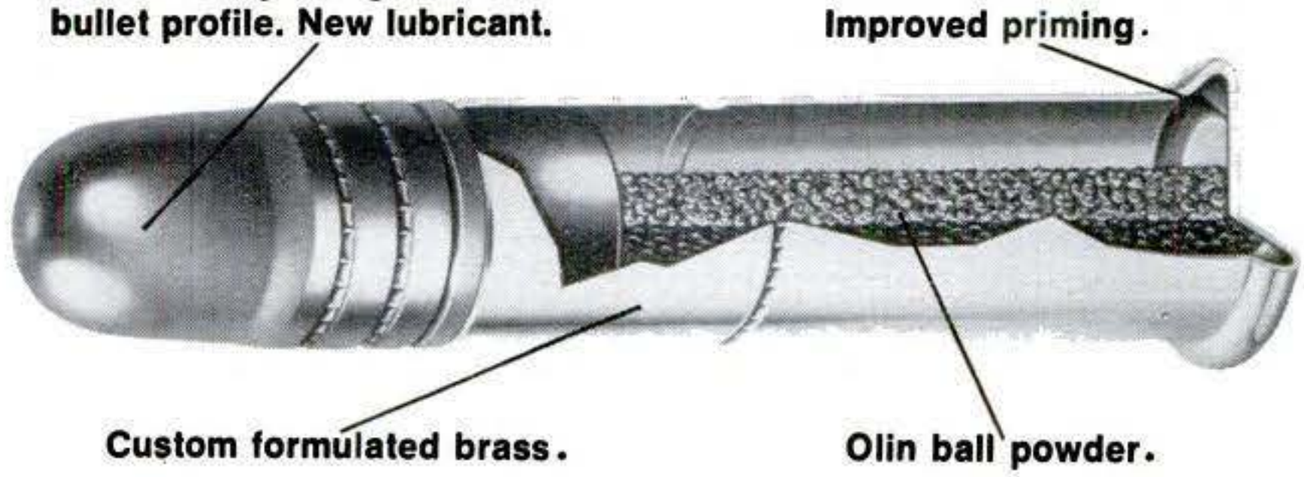

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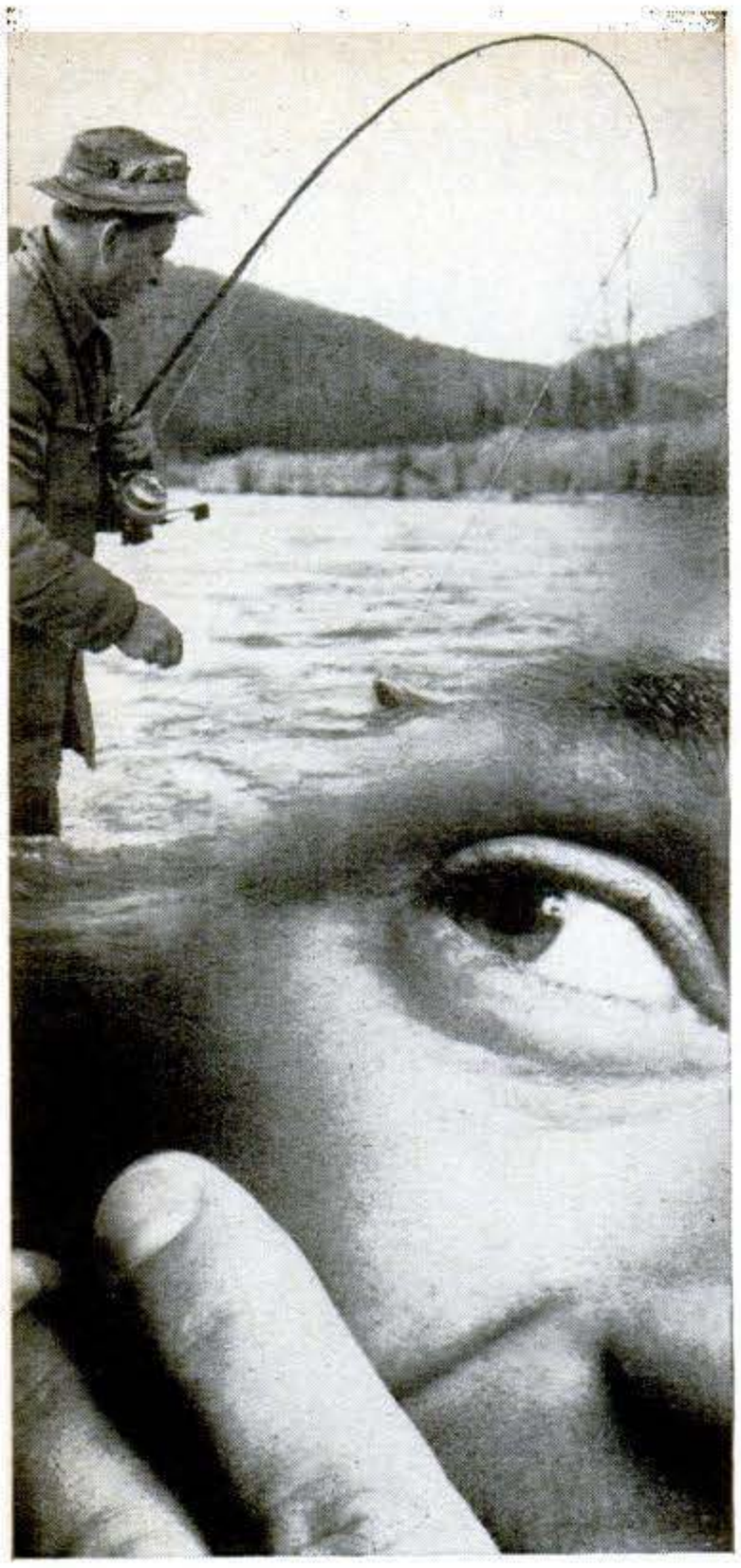

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THE What's New MAGAZINE™

JUNE 1972 Founded in 1872/Vol. 200, No. 6

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New ESVs: Race to Build the World's Safest Car PAGE 54

They're building, test-driving, and crashing costly research vehicles for design know-how that may let you walk away from a "fatal" crash.

Dr. Wankel Re-Invents the Boat PAGE 58

His fantastic Zisch-boat will drive like a car at turnpike speeds—on the ocean.

Fail-Safe Tire Lets You Drive on a Flat PAGE 64

Blowout! But now you'll drive right on—as fast as 50 mph—safely.

Plate Tectonics—Startling New View of Our Turbulent Earth PAGE 84

Terra firma—it's anything but. The continents are turning, tilting, drifting, and plunging over the semi-molten layer beneath.

Hang Gliders: Far-Out Fly-Yourself Craft PAGE 92

Wearing your wings, you hang by your armpits and fly low and slow.

COVER PAINTING BY TED LODIGENSKY

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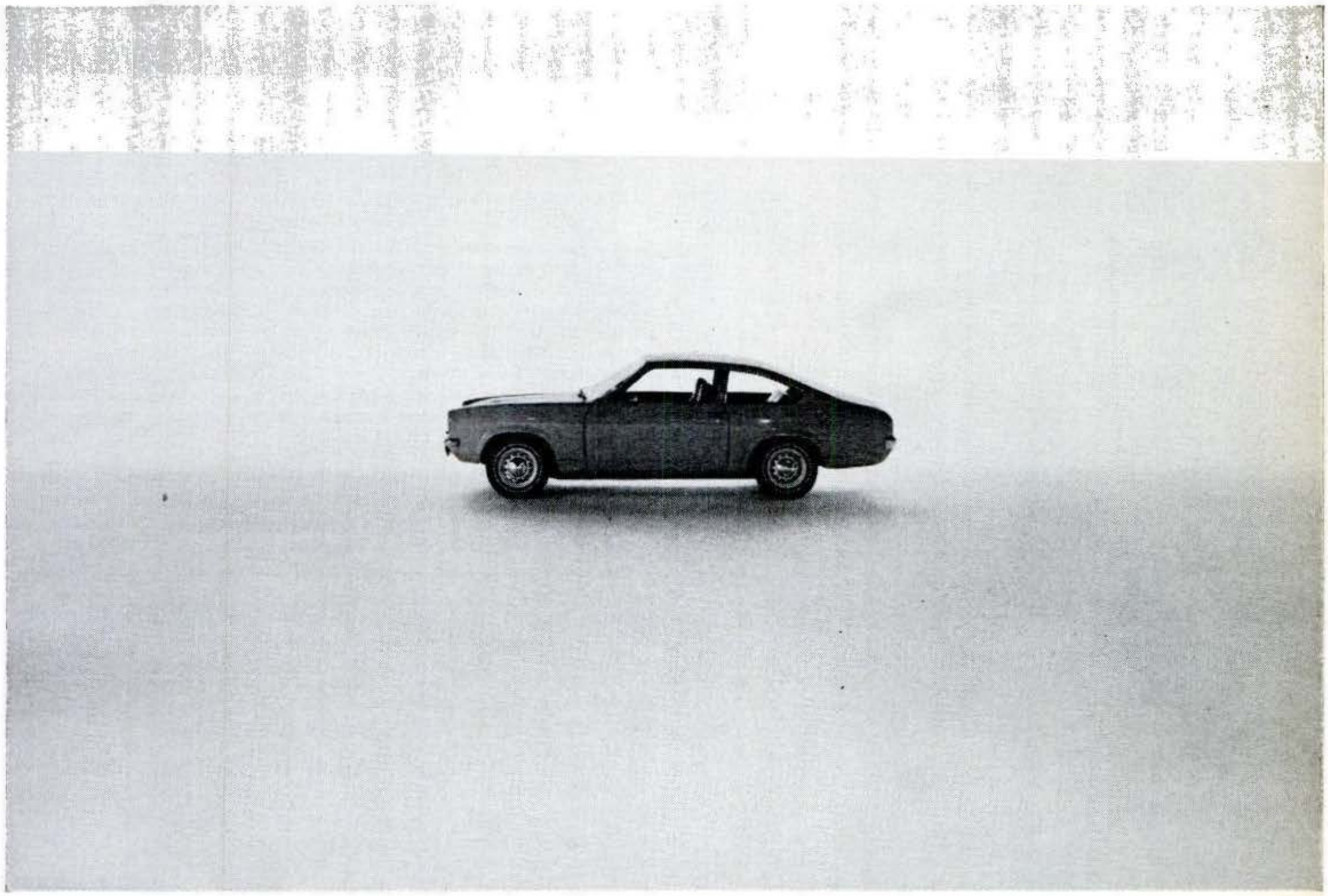
The oil that stands up for the little guy.



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What's New NEXT MONTH

Sneak Preview of the '73 Cars: The Year of the Bump-Proof Bumper

Fantastic New Scopes Let You See in the Dark

Instant Housing: Build a "Vacation Cluster"

Way-Out Gadgets from the Brussels Inventors Show

Car Overheating? Here's How to Keep Your Cool

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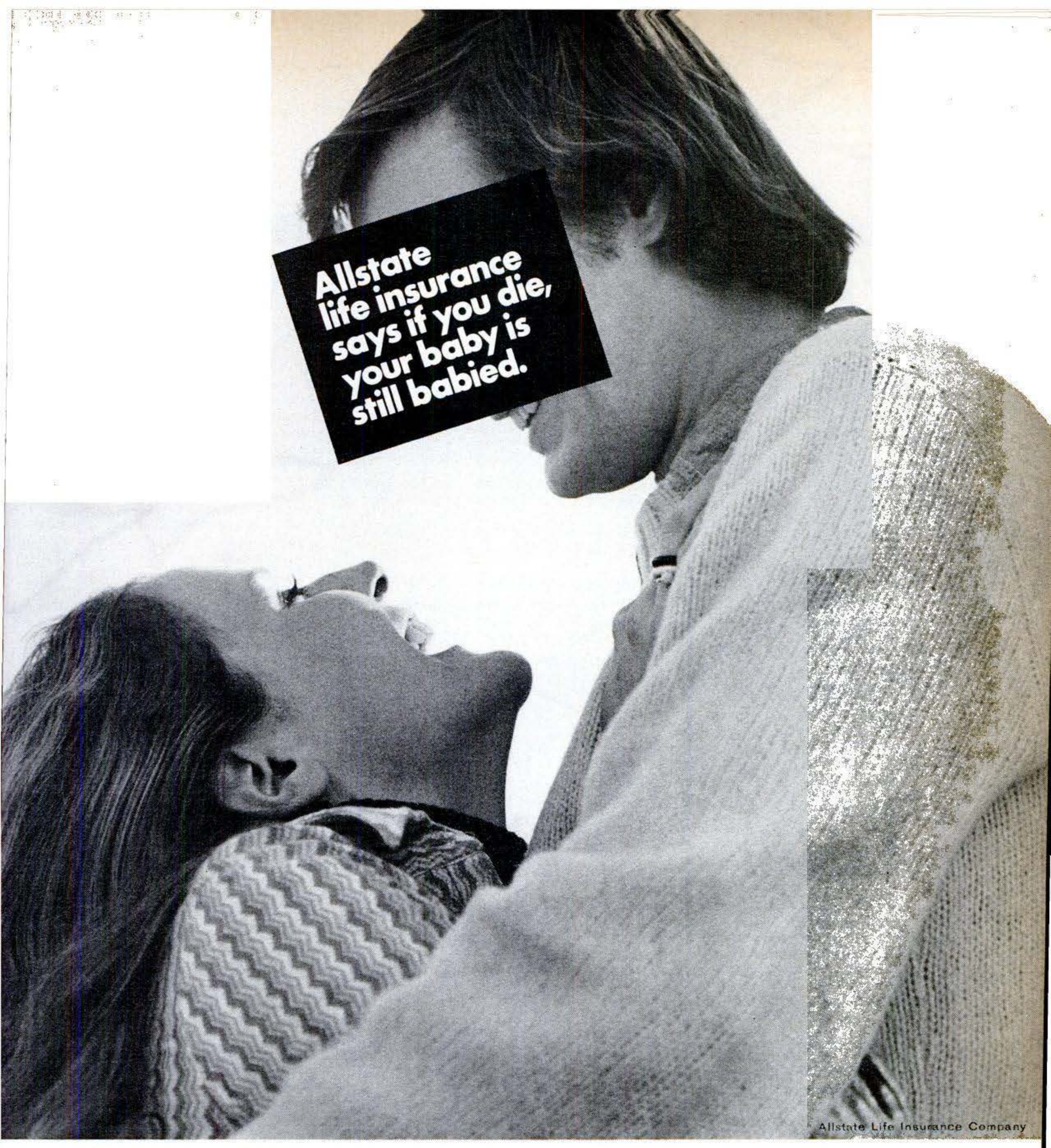

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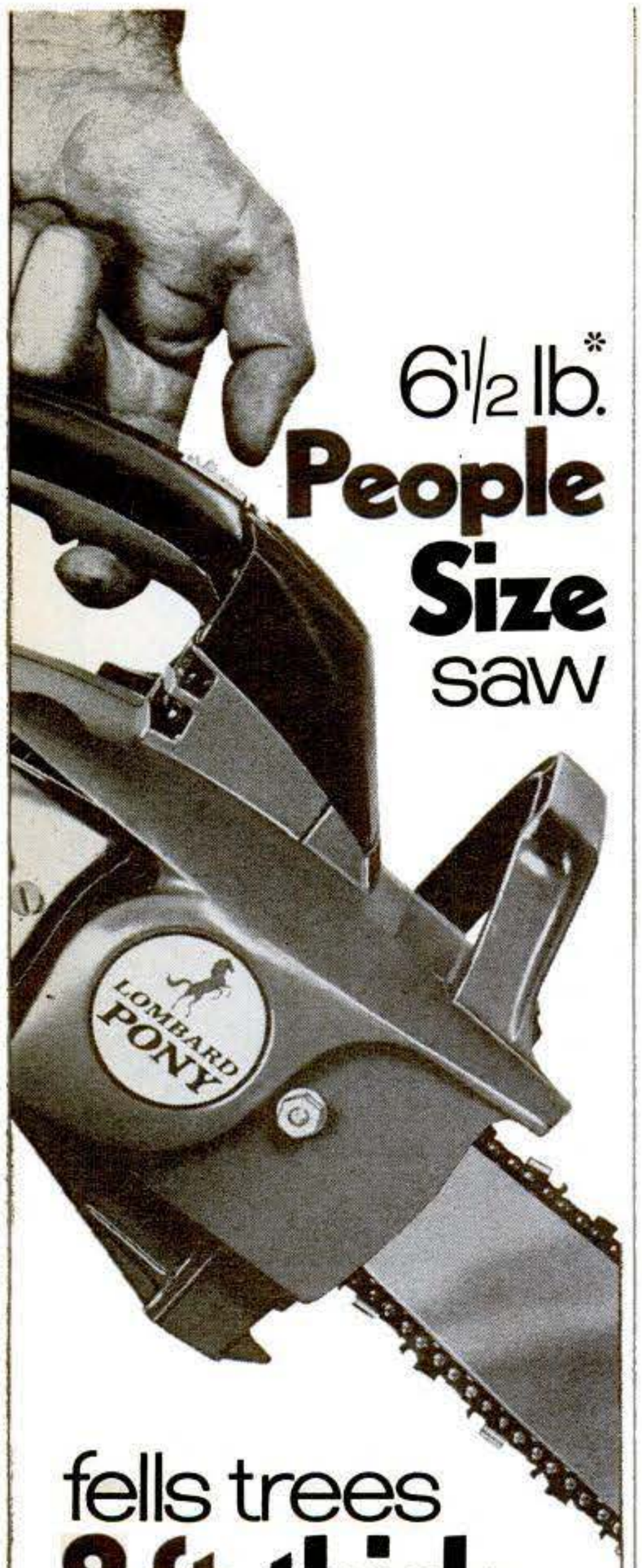

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PS Readers Talk Back

Where you voice your views . . . and the editors do the listening

Where do you put the oil?

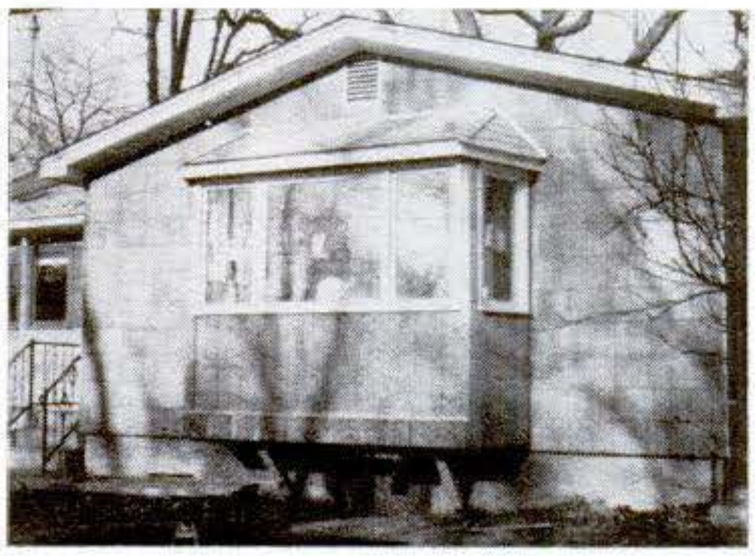
What does a do-it-yourselfer do with the used crankcase motor oil when it has been removed from the vehicle? In the interest of controlling pollution and in not upsetting our ecology, I'm curious as to what POPULAR SCIENCE recommends for this practice.

R. A. GENTRY, Winfield, Kans.

Good question. None of the editors here has a solution he is willing to recommend. We'd like to hear from readers who have dealt successfully with this problem.

Adding a bay window

I took your suggestion in the article "Cantilever: A Good Word for More Living Space" [Apr., '71] and added a



bay window to my kitchen. Everything is completed except removing the old window and finishing the inside. All I had to go by was the drawing and the article. Enclosed is a photo showing the results.

FRED FUENTES, Wonder Lake, Ill.

Power-tool parts needed

I've tried to contact the firm that makes the Shopsmith 10ER without any luck. My letter was returned stamped "No such address." I need some spare parts to repair it. Can you help?

A. M. ALCANTARA, Barstow, Calif.

According to our records, the Shopsmith is no longer being made and the company that took over the original firm has gone out of business. If anyone knows where to get spare parts, we'd like to hear from you. Other readers have the same problem.

Power for your welders

E. F. Lindsley's article "Two Home Shop Welders That Really Work" [Mar.] is very interesting, but unfortunately omits the matter of current supply. My own house supply is a 100-amp circuit, three-wire, which furnishes 110 volts, 50 amps between each hot wire and the ground or 220 volts as 100 amps between the two hot wires. I had considered having my service rewired to the heaviest home service that is common in this locality—200 amps, three wire. With either of these services, where do the 230 amps come from?

E. G. FRANCIS, Ormason Beach, Fla.

Lindsley replies: "Ohm my. Guess I took it for granted everyone knew such welders step down voltage and step up amperage by transformer action. In the welder, the 115-volt line current is stepped down to 15-30 volts, and amperage you can draw is stepped up proportionately. My home has 100-amp service, too. Small welder takes only 30-amp fuse, big one needs about 50-amp fuse in each leg of 220-volt feed."

Camping: Bikes, tents, sleeping bags

We sincerely appreciate the nice things A. J. Hand said about our tents and sleeping bags for bicycle campers in "Bicycle Camping—What you need to know to join the fun" [Apr.]. To avoid confusion, though, your readers should know that the correct name is *Stephenson* not Stephens, and that since we've been deluged with orders there is a five to seven week delivery delay on most of our items.

JACK STEPHENSON,
Woodland Hills, Calif.

What about your seat belts?

Re "The Seat Belt Story" in PS Readers Talk Back [Mar.]: I agree with J.B.W. and his problem of being choked by roof-mounted seat belts. I have a 1968 four-door Valiant and the belt is located so that it feels like it might snap my neck off in an accident. Ralph Nader ought to know about this.

W. T. STANDISH
Linthicum Hgts., Md.

. . . Whoever wrote "The Seat Belt Story" letter must be spastic or something. We have two new Buicks in our family and never have any trouble. Any fool can use these belts with ease. They're not "confusing and difficult to put on" as the writer indicates. The shoulder harness can be a bit uncomfortable. If that's the case just use the lap belt; it's better than nothing.

HUNTER COCHRANE, Baltimore, Md.

Dream car not so dreamy

I recently test drove the Pantera that you reported on in your article "Ford's

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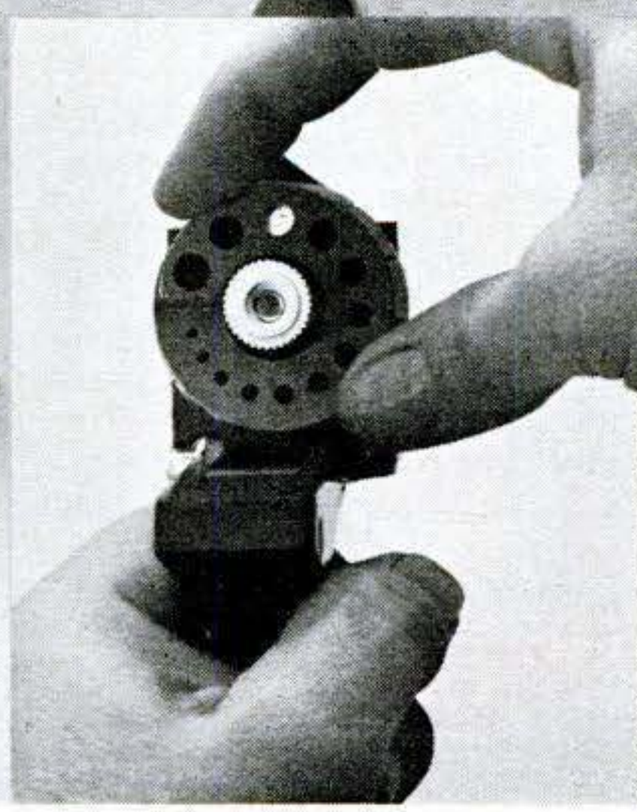

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PS Readers Talk Back

[*Continued*]

Dream Car You Can Buy Now" [Apr.] and disagree with some of your findings. You neglected to mention that front-wheel housings encroach on the passengers so that occupants must sit with their legs skewed toward the centerline of the car. Also, the engine is like an iceberg—you can only see a third of it. To get at something like ignition timing or accessory drive belts, the bulkhead between the engine and the cockpit must be removed. I do give the Pantera credit for its exceptional steering, and I consider the car roomy for a mid-engine. But I don't think it's worth the ten grand.

SAM BEJAR, Miami, Fla.

Lead-free gas here to stay?

In "The View Down the Road" [Apr.] Mr. Norbye states (from where he sits) that the "oil lobby" must have "persuaded Washington" that lead-free gasoline is undesirable. As I see it, the problem is with the consumer. Lead-free gas has been available in some parts of this country for 25 years and here in our area for two years. If you ask any service station how much lead-free gas they sell, you'll find the amount close to zero. The ordinary auto owners are so confused by what they read about the lead controversy that they're waiting to see which way to go. In this day and age of "instant" everything, some premature conclusions have done a great deal of harm to the consumer.

R. E. FRANCE, Whittier, Calif.

Homemade freezer alarm

I'd like to build your freezer alarm ["Keep Your Cool—with This Homemade Freezer Alarm," Mar.] but there's a problem before I begin. I see that a comma has been misleadingly printed in the R9 resistor value—33,00-ohm. Please advise if it's 3,000 or 33,000 ohms.

W. B. PETERS, Florissant, Mo.

Sorry. We left out a zero—which could make a big difference. Resistor R9 should read: 33,000-ohms.

Kite flying grows

We have received 284 new memberships in the American Kitefliers Association since the publication of "Kites Go Scientific," [Mar.]. So many mem-

berships have come all at once from every state in the union, Puerto Rico, West Indies, and Canada and Mexico that I'm convinced your article was the principal cause. I have no doubt that we will hear about the article for several years to come. We still receive memberships based on information published in stories as long as five years ago. And POPULAR SCIENCE is the kind of magazine that kicks around for a long time.

BOB INGRAHAM,
American Kitefliers Assn.
Silver City, N.M.

Do-it-yourself fishbowler

Enclosed is a photo of the fish bowl I made ["Smart Fish Bowl Under the

Table," July, '71]. Unlike the bowl featured in your article, I used walnut and set mine up for tropical fish. I built my own filter out of plastic, and it uses charcoal and polyester fiber for the filtering material. I epoxied gravel to the outside of the filter so it blends in with the gravel on the bottom of the bowl. After four months of operation, I must say I'm extremely pleased with it, and it amazes everyone who sees it.

STAN JANCZURA, San Francisco

Glue for green wood

I read with interest your article on the polyethylene glycol (PEG) treatment of wood ["How to Work with Green Wood," Apr.]. With one exception the article is technically correct. Our work at the U.S. Dept. of Agriculture indicates that polyvinyl glues such as Elmer's are completely unsatisfactory on glycol-treated wood. I am enclosing the correct information from a Forest Service Research Note.

HIRAM HALLOCK, U.S. Forest Service, Madison, Wis.

The Research Note states: "Resorcinol and epoxy glues, and certain urea-melamine mixtures (URAC-185), have been used successfully in laminating glycol-treated gunstock blanks. For best results the treated wood should be wiped with toluol and then alcohol before the glue is applied. In small lots, polyethylene glycol can be obtained from Crane Creek Gun Stock Co., Waseca, Minn., and from Forshaw Chemicals, Inc., P.O. Box 6165, Charlotte, N.C."

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 355 Lexington Ave., New York, N.Y. 10017.

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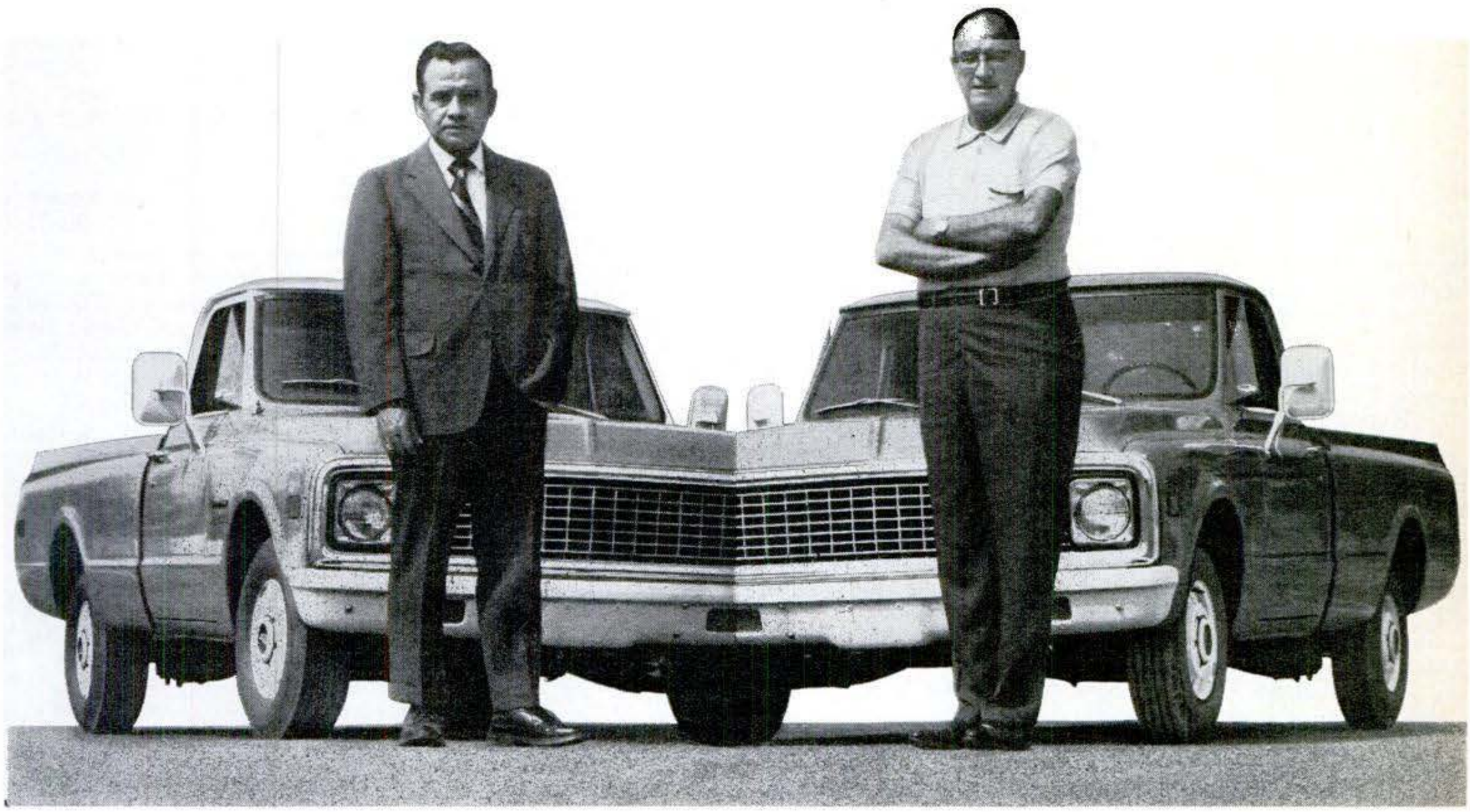
I can buy passenger car tires for less than truck tires and get the same mileage out of them.

I can buy truck tires for less than car tires and get more mileage out of them.



Do you know which man is right?

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"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" Popular Science, 355 Lexington Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

I was surprised to learn there are solid lifters, instead of hydraulic, in my recently purchased '72 Dodge Dart with a 225-c.i. six engine. Why is this necessary in a relatively low-performance engine? How often should the lifters be checked for adjustment? I heard that this power unit is robust and noted for long life, but it has only four main crankshaft bearings. How can it achieve the same life as other sixes that have five and seven main bearings to support the crankshaft?

ELDON H. COOK, Baton Rouge, La.

Solid lifters are cheaper than hydraulic. Four main bearings are cheaper than five—so the main answer is money. It's a pretty good little engine but, everything being equal, an engine with four mains would wear faster than an engine with five or seven main bearings. You should check valve lash about every 15,000 miles, or once a year—or when you hear the lifters, or have a skip that a tune-up didn't stop.

My 1971 Fury 360 c.i.d. poured oil through the oil-filter base on several occasions until a new oil pump was installed at 3,500 miles. On one occasion the engine was run for about 30 seconds without oil pressure and a lot of smoke came out of the engine. According to the dealer, the engine wasn't affected, and it doesn't make any unusual noise during regular operation. I'm planning a 6,000-mile trip to Central America. Can I depend on this car? What are the chances that the oil pump will fail again?

JAIME MOSQUERA, M.D., St. Louis, Mo.

I can only make a guess from here, but I'd say an engine in good shape run only 30 seconds without oil pressure at low rpm with a small or mild load wouldn't be hurt at all. But it would be damaged if it was run without oil pressure at full power and full rpm. As to whether the leak will occur again, I doubt it, assuming the work was done properly.

Are the auto makers trying to cut in on some of the big profits in oil additives, or are additives really needed? Now Chrysler recommends their Hi-Performance additive be used at every oil change. Also, GM is recommending that their "Super Engine Oil Supplement" be added to engine oil. What do you say?

KEN HARTMAN, New Albany, Ohio

My stand on additives is often misunderstood, so I'll state it here. There are some problems that can be chemically treated—if you use the proper chemicals in the proper way and the illness is correctly diagnosed. I don't believe any chemical can cure a worn-out or damaged engine or gearbox. Chemicals can help as preventive-maintenance cleaners, provide temporary relief from immediate repair, and in some cases fortify an engine for extreme conditions. The manufacturers' claims? Well, to me some of them resemble some of the political campaign promises we're hearing so much now and that have such a horsey odor. I don't really know how to tell you who's telling the truth. Hopefully, all claims will have to be backed up and documented to consumer controls bureaus.

I have a '68 Valiant with 27,000 miles. The switch that controls the A/C heater or defroster keeps burning out. The Chrysler people replaced the switch six times, and it lasted no longer than two weeks. Then they found a short in the motor controlling those units and replaced the motor. Three and a half weeks, and busted again! This now has cost me over $100. The dealer has given up and no one else wants to fool with it since the company failed to fix it. What's the cause and correction?

SIDNEY SHOLL, Flushing, N.Y.

Go to an automotive electrician and have him check the load on the switch. With all systems operating, check the load against the switch capacity. Correct draw on the heater and A/C components is recorded in the service manual. Assuming that you're going to find the current draw too high, look for a wiring problem or a defective component. If the draw is over the switch capacity, you'll have to install a switch with higher capacity.

I recently read several articles which might make people believe that unleaded gasoline will wreck engines. I know that high-compression engines can't do without lead unless they substitute alcohol as an additive. My question is, how can diesels run from 100,000 to 150,000 miles between overhauls? They don't have leaded fuel to keep them from falling apart.

F. H. SUTTON, Los Angeles, Calif.

Lead versus no lead got a very good argument both ways. I doubt that removing the lead will cure all the problems, though I don't doubt that an engine can be made to do quite well without lead. There is no way to compare diesel with gasoline engines, really. For example, the best diesel engine doesn't even have intake valves.

But, I know what you're getting at, and my answer is this: Nothing that has been discussed publicly will really fix the problem. Anything we do to the engines or fuel as we know them today will be—at best—patch jobs to the real answers. Those lie somewhere in power plants and possibly fuels we never heard of. I'm convinced that someone in this world will someday raise his hand with the right answer.

With 19,000 miles on the speedometer, my '71 Pinto developed an oil leak. Because of a bad oil-filter seal and a faulty oil-pressure light, I drove it several miles at freeway speeds without oil. The leak was fixed, but now the car doesn't have the power it used to have on hills. Does this mean a ring job, or what? Will an additive help?

BILL SALE, Pala, Calif.

Have the engine blown down with a Sun compression analyzer. If the rings are hurt, it'll show up as a big compression leak. If that's the case, the cylinder walls are scored and won't be helped with chemicals. If the rings are stuck, chemicals will probably fix that. If it leaks compression, how can you tell whether the problem is caused by scoring or stuck rings? No way, except to pull the head. Also, running without oil may have damaged some bearings, creating a lot of drag in the engine. If that's the case, by the time you read this you've probably already found out.

Every time I turn off the ignition in my six-cylinder 1971 Chevy Van, it diesels. What can I do about this, besides taking it to the shop?

C. B. HASSEN, New Orleans, La.

Assuming you're going to fix this yourself, get hold of a service manual for specifications. Check the idle speed, carburetor adjustment, timing, and dash pot. Be sure you have the right fuel specified. If the engine has a lot of miles on it with carbon buildup, the carbon has to go. As a rule, dieseling is hard to fix and keep it fixed, so unless you're very handy, I'd suggest a good repair shop.

My 1964 Cadillac has 76,000 miles on it and a recent ring and valve job. Since the job, oil has been blowing out through the breather cap and collecting on the manifold. Although the car appears to burn no oil (clean plugs and exhaust pipe), it uses a quart per 1,000 miles. The dealer says this is not excessive consumption. My compression is good and I have changed the PCV valve and

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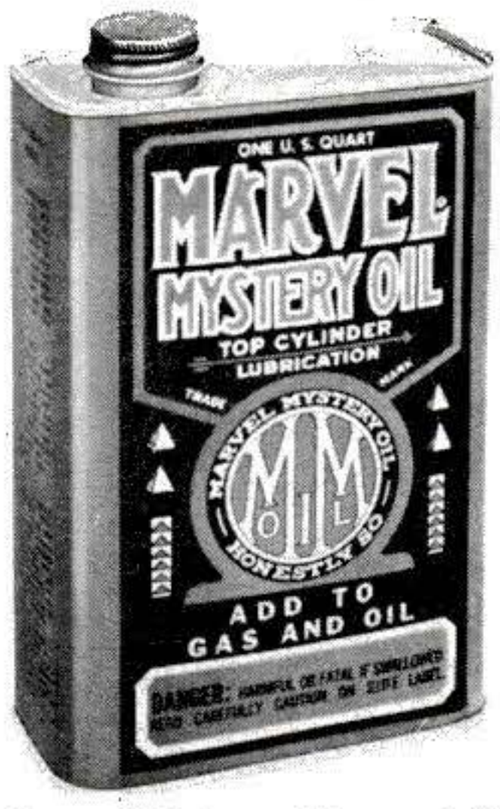

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"Say, Smokey—"

[Continued]

cleaned the hose in the PCV system to no avail. The Cadillac dealer is stumped. Can you help?

JAMES I. MUIR III, Athens, Ga.

Sounds like the oil pressure was increased by the ring job. I assume you had bearings put in also, and your rockers are worn, and now you've flooded the valve-cover area and it's tossing the oil out. But to pin this down, check the crankcase pressure and valve-cover pressure. If it's not normal, you've still got a ring problem. Sometimes after a few thousand miles a ring job holds much better.

I own a '67 Sunbeam Tiger with a Ford 260-c.i. V8 engine. Recently, turning the steering wheel has become very difficult. The steering is the rack-and-pinion type. My car manual says the only source of lubrication is ½ pint of steering fluid which is supposed to be contained in a closed system. There are several universal joints in the column but no grease fittings. Could you suggest a solution?

RUTH SCOTT, Colchester, Vt.

Don't keep driving with this problem or you're going to be hurt. Have the steering removed, examined, and fixed before it locks on you. When they start to tighten up, steering assemblies of this type are dry and galling up.

I'm interested in buying a Chevrolet Blazer—two-wheel drive, all-coil suspension with either the 307 or 350 engine. My question is: How does its stock suspension compare with the Camaro in regard to ride, handling, and stability, considering that the Blazer sits much higher off the ground? The Blazer would be used both for passengers and as a utility truck.

M. KUNISHI, Beltsville, Md.

I think you'd be satisfied with the Blazer ride, but it'll be rougher than the Camaro, as you suspect. Why not go to a dealer and ride one, and you'll know exactly what you're getting.

My '69 six-cylinder Rebel station wagon has been stalling since the day I bought it. Whenever I stop or turn a corner, it stalls when I attempt to accelerate. The carburetor was changed twice in the first six months, but this didn't help. The dealer said the problem wasn't caused by the carburetor, and refused to fix it again. I say he's wrong. The car performs satisfactorily in every other way. Help.

JOSEPH R. PETERS, Andover, Mass.

Assuming you're telling it like it is, I recommend you look for a good carburetor man who can adjust the float level and get the needle and seat to hold properly. He should also know how to get the accelerator system richened up in the carb. One more thing: Be sure the distributor advance is operating at specs and that you have the plugs recommended for that engine model. PS

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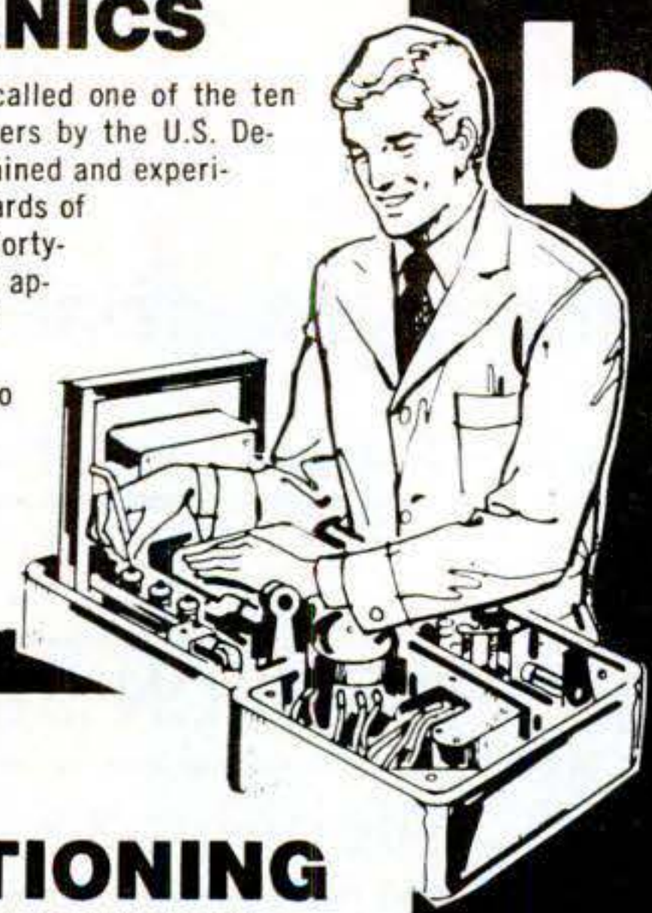

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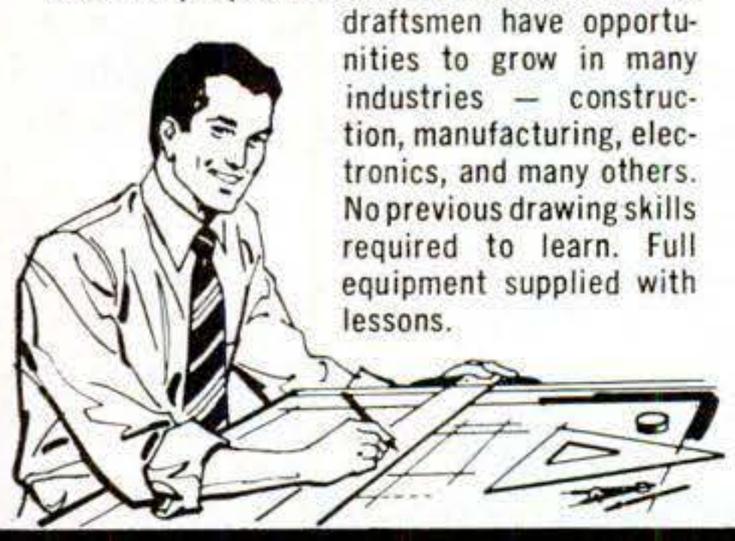

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Rating th

In tests by two of Europe's leading motor magazines, steel-belte

1969: Auto Motor und Sport Magazine

1ST	Uniroyal 180	(Steel)
2ND	Michelin XAS	(Steel)
3RD	Phoenix Sen.	(Fabric)
4TH	Metzeler Monza	(Fabric)
5TH	Fulda P 23	(Fabric)

1970: Auto Motor und Sport Magazine

1ST	Uniroyal 180	(Steel)
2ND	Pirelli CN 36	(Steel)
3RD	Michelin zX	(Steel)
4TH	Kleber V 10	(Fabric)
5TH	Semperit	(Fabric)
6TH	Dunlop SP 68	(Fabric)

These tests included: handling on curves, steering exactness on a zig-zag slalom course, braking distance and behavior, acceleration and skid resistance on a wet circular track, comfort and wear. In addition, Auto Motor und Sport included a test for tire noise in '69, winter suit-

Although radial tires are big news in the U.S. today, they have been widely used in Europe—and increasingly preferred—for the past fifteen years.

To a European motorist, the question today is not whether to get a radial, but what kind of a radial to get.

To help answer that question, two of Europe's leading motoring magazines—"Auto Motor und Sport" and "Auto Zeitung"—conducted exhaustive track tests of the most famous European radial tires. (Test criteria are described above.)

The results show that steel-belted radials as a group received higher overall ratings than fabric-belted radials, winning both first and second places in 1969, 1970 and 1971. They did not, of course, win in every test category.

The steel-belted radial tires have a built-in advantage which was not included in these tests—substantially greater protection against cuts and punctures—because the belts under the tread are made of steel wire. (Cuts are the major cause of tire failure, by the way.)

Uniroyal steel-belted radials are now available in the United States.

We are pleased to be able to tell you that the Uniroyal 180 steel-belted radial—which won first place

e radials.

ial tires received higher overall ratings than fabric-belted radials.

1971: Auto Motor und Sport Magazine

1ST	Metzeler Monza	(Steel)
2ND	Conti TS 771	(Steel)
3RD	Uniroyal 180	(Steel)
4TH	Phoenix Sen.	(Fabric)
5TH	Fulda P 25 Rib	(Fabric)
6TH	Goodyear G800	(Fabric)

ability in '70 and aquaplaning tendency in '71.

1971: Auto Zeitung Magazine

1ST	Uniroyal 180	(Steel)
2ND	Michelin zX	(Steel)
3RD	Pirelli CF 67	(Fabric)
4TH	Conti TS 771	(Steel)
5TH	Kleber V 10	(Fabric)
6TH	Conti TT 714	(Fabric)
6TH	Fulda P 25 Rib	(Fabric)
8TH	Dunlop Sp 57F	(Fabric)
9TH	Phoenix P110Ti	(Fabric)
10TH	Bridgestone	(Fabric)
10TH	Metzeler Monza	(Steel)
12TH	Metzeler Monza	(Fabric)
13TH	Goodyear G800	(Fabric)

overall in three out of four of the above series of tests —is now available in this country in sizes to fit most of the popular European cars.

In addition, Uniroyal is now making a steel-belted radial especially designed for American cars, called the Uniroyal Zeta 40M. This tire is being produced in the United States.

Other companies are beginning to offer you steel-belted radials. But bear in mind that the steel-belted radial is a more difficult tire to make because steel is a more difficult material to work with.

Uniroyal has made more than 20 million steel-belted radials over the past 12 years, and knows how to make them properly.

In fact, there are only two tire companies in the world that have this much experience in making steel-belted radials—Michelin and Uniroyal.

When you go to buy a steel-belted radial, don't let them sell you just a radial tire or a steel-belted tire. It's not the same thing.

Here is how to tell what you're getting. If the dealer tells you it's a "radial tire", you can be pretty sure it's a fabric-belted radial. If he tells you it's a "steel tire," the chances are it's a steel-belted bias construction. (That is, a conventional tire, without the performance advantages of a radial.) If it's a steel-belted radial, you can bet your boots he's going to let you know it!

Would you like to know the name of a dealer in your locality where you can get Uniroyal steel-belted radials? Telephone (800)-243-6000 anytime, free of charge. In Connecticut, call 1-(800)-882-6500.

Would you like to get a complete and unabridged English translation of the reports of all four of the radial tire tests described above? Send 25c to Dept. GP, Uniroyal, Oxford, Connecticut 06749. When you're finished reading this series of test reports, you'll know what to look for in radial tires.

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Mulcher by Gilson digests large amounts of trimmings and shoots out small quantities of chopped-up mulch for use or disposal.

Lightweight cordless trimmer makes it easy to keep the front hedges in shape. The Black & Decker unit recharges overnight.

Trimmers, Edgers, Vacuums, Shredders...

The New Yard Tools That Finish the Job

Can gardening be fun? Yes, if you use the new labor-saving tools on backbreaking jobs

By E. F. LINDSLEY
PS Midwest Editor

Ten to one, by midsummer your lawn will have power-mower scruff—a look of cut but unkempt raggedness. Like most of us, you probably mow one gear too fast. You don't have time to creep, back, and cramp to get in tight, so you leave a scraggly margin of unsightly rank growth around trees, foundations, curbs, and posts. That's scruff.

One way to beat scruff is by hours of snickety-snick work with hand shears, tedious raking, and spade-width nibbling at edges. But it's more fun and a lot faster to use power tools made for the job. There's a heap to choose from. Here's what I found:

- *Grass shears.* You can buy hand-held or extension-handle types, clipper or rotary, plug-in or cordless.
- *Trimmers.* They're huskier than shears and come electric- or engine-driven. Some are able to clean up twig-size growth, coarse grass, and rough messes under hedges.
- *Edgers.* Frequently, these are trimmers turned to cut vertically. Electric- or engine-powered types are available, as well as those that can also trench, scarify for grass planting, and slash under sod.
- *Rakes and brushes.* They're self-propelled or mower-pulled, and some can dig out thatch.
- *Lawn vacuums.* They're for fast cleanup of leaves, grass cuttings, trash. With suction pipes they pull trash from window wells and hedges.
- *Hedge trimmers.* Some are cordless, others are gas-powered.
- *Shredder/baggers, composters, and chippers.* Mostly gas-powered, they reduce big volumes of junk to mulch or bagged waste.

These tools are real time savers. Studies by Jacobsen show that two hours of hand grass trimming can be reduced to six minutes with a power trimmer; two hours of hand raking can be done in 12 minutes with a sweeper; and an overall 12 hours of yard chores can be finished in an hour and 43 minutes with power.

Trim-up tools. Most frequently used tools? Probably the self-powered grass shears from Disston, Sunbeam, or Black & Decker. These handy and most wonderfully light (under two pounds) shears recharge overnight. Differences? Sunbeam offers a $7 extension-handle kit with wheels. Black

Continued

Dual-hopper chopper grinds trimmings as big as a kid's baseball bat. A bag at the Omark unit's outlet holds the shreddings.

Golf-club-type trimmer eliminates need to bend down in hard-to-get-at spots. B&D unit features a replaceable rotary blade.

Self-powered grass shear from Disston puts the finishing touch on your lawn. It weighs in at just under two pounds, costs about $20.

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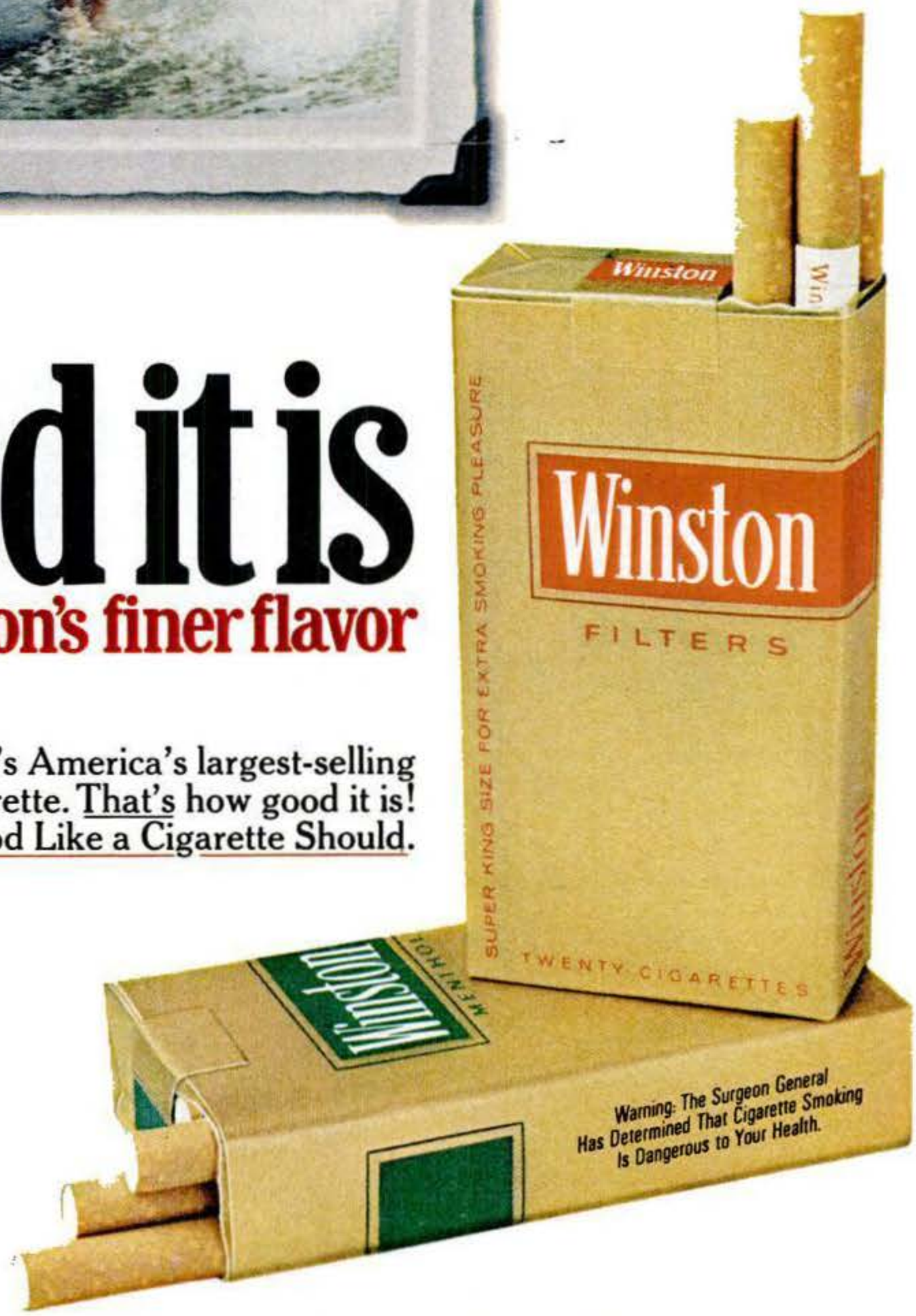

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No need for hand shears and rakes; beat the scruff with "power"

Heavy-duty lawn edger cuts a ¾-inch trench along sidewalks and driveways. The price of the B&D unit? About $40.

Versatile edger/trimmer by Sears twists and angles for routine edging, yet clears heavy thickets. Cutting depth is adjustable.

Edger/trimmer cutter on Parkton mower finishes job as you go. Cutter is detachable, tilts 90 degrees, and has adjustable depth.

& Decker has an upright model with an optional sharpening stone to sharpen the blades under their own power. Disston blades have a no-stick coating. Competition is hot: All hand types sell in the $20 range, down almost $10 from a year ago.

Rotary grass trimmers look like a cross between golf club and back scratcher, and whirl small, light cutter blades usually four inches or less in diameter. The trick is to use a slow-swinging, scythe-like stroke.

Ordinary lawn grass can be whisked away fairly well with the self-powered battery types. For tough, dried, coarse grass, the cord types work better. Many rotary trimmers feature blades that are reversible and replaceable. Typical trimmer prices: about $13 for Black & Decker's cord type, $30 for Rockwell's cordless.

Edger/trimmers. Jumping from purely trim-up tools to edger/trimmers, your choice gets complicated. There are trimmers that edge lightly, edgers that trim, mowers that edge and trim, edgers that fell thicket growth, and edger attachments for tillers.

Power and weight are the keys to performance in edger/trimmers. Obviously, Black & Decker does not expect their 9¼-pound, $28 trimmer with a 1/10-hp motor to rip out dirt along a sidewalk edge like their half-horse model. The lightweight is primarily for trimming, but it will edge up some walks. For about $40, Rockwell has a 1¾-hp dandy that can gnaw a fresh, clean edge on a flower bed or trim in the bracken with authority.

Skil, Wards, Sears, and some others have cord-type electrics in the $30 and $50 range. The electrics tend to be single-handle rigs with wheels that work best on level ground. Most lack wide-range depth adjustment, but they do a fine job along walks and plantings.

The engine-powered edgers are pretty much go-anywhere, rough-and-tumble, two-handle machines with a sometimes confusing variety of adjustments. We tried a Sears model that lets you cant the blade 110 degrees from vertical to horizontal extremes. If you have a curb, this one will roll along with one wheel in the gutter and the guide wheel riding the top of the curb for depth control.

Thinking about a walk-behind rotary mower? Check out the Parkton Satellite, a combined mower and edger/trimmer. The "satellite" (edger/trimmer) unit is removable. To edge, just flip the control handle and the blade locks into a vertical plane.

Jacobsen has offered edger/trimmers for a long time. They have two- and four-stroke engine models to do almost anything in the line of edging, trenching, slashing under sod, and working close to buildings. If your lawn runs right up to a building or fence, choose a machine with handles that are either offset or narrow enough to run parallel to the wall without scraping your knuckles. Bunton has offset handles just for this reason. Gas-powered edger/trimmer prices? You get what you pay for—from under $70 to more than $150.

Lawn sweepers. The hand-push kind is effective. With a hitch rig, it will probably pull behind your mower to sweep as you go. This (or a self-propelled type) gets rid of a lot of heavy stuff and the collected cuttings make good mulch. If you want to dig deeper, investigate Sears' power-rake attachment, which goes with their 3½-hp sweeper. Or rent a thatcher.

Lawn *vacuums* will clean up grass cuttings either as behind-the-mower units or self-propelled or push-type outfits that look like an overnourished Hoover. They'll do some jobs a sweeper doesn't handle well, such as cleaning surfaced drives and patios, swishing wind-driven leaves and trash from hedge rows, and dragging reluctant junk out of window wells. The kind with the big extension hose is needed for the latter jobs.

Big cleanup machines. I had already tried Sears' shredder/bagger ["Chomping Machine Chews Up Yard Waste," PS, Feb. '71] and thought it was one of the finest cleanup machines you could have. Now others—Toro, for one—are making them.

Differences? Mulchers are intended primarily to chew up waste organic matter to make compost or mulch. Chippers and clippers take almost any waste—including small tree limbs, solid junk such as cardboard, plastics, and even cans—and reduce it to bits. If solid-waste disposal is your problem, one of these husky (eight-hp and up) outfits could solve it. For ordinary grass, hedge trimmings, and small branches, the shredder/bagger, with or without bags, will do.

Hedge and shrub trimmers. With scruff cleaned up, you'll find that untrimmed bushes and hedges stand out painfully. Quick licks on these are possible with the new cordless trimmers. Black & Decker's new 8184 (under $50) or Disston's CEHT-1 ($59.99) are both rechargeable-battery types and can hack most of the routine trimming. For lighter service, try Disston's CEST-2 (under $30). On the heavy-duty side, Wards has a $100 gas-powered 30-inch trimmer with a one-hp O&R engine. PS

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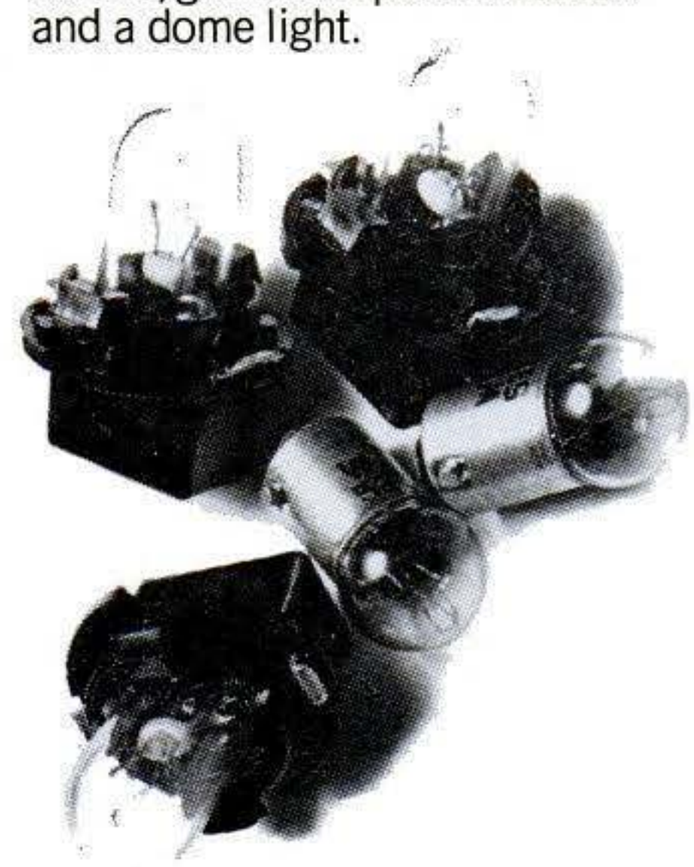
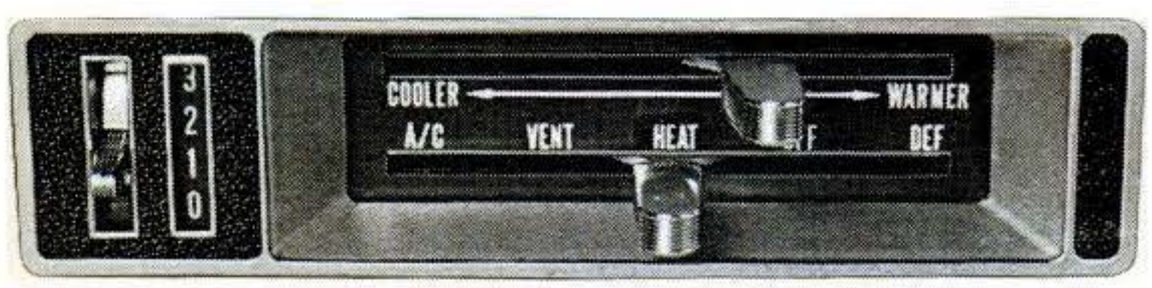
Standard things like an ashtray.

And little optional niceties like a parking brake warning light, a dual electric horn, a padded horn button, glove compartment lock and a dome light.

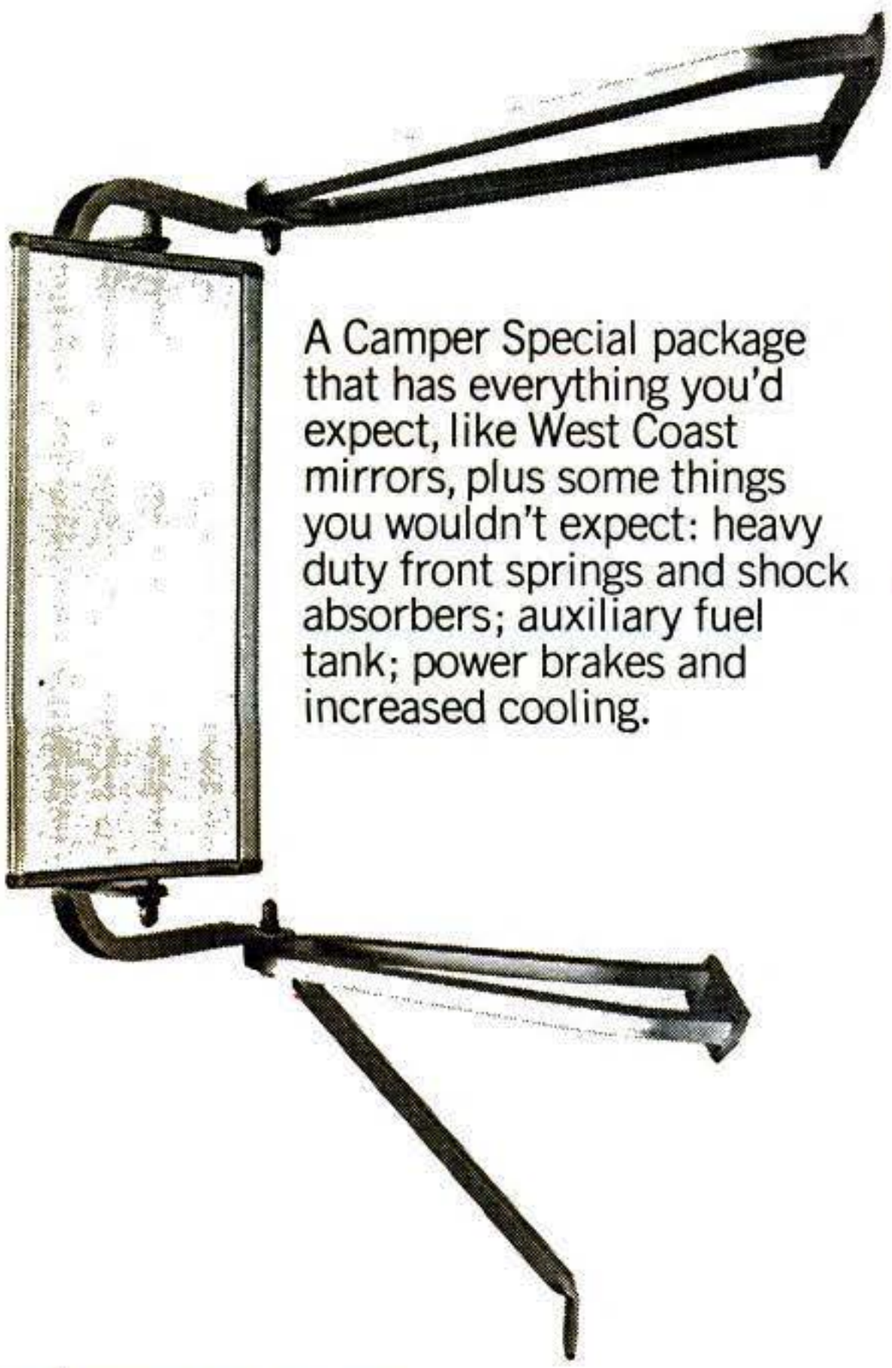


Options like power steering, power brakes, an automatic transmission plus four other kinds of transmissions including a 5-speed. Four wheel drive. And standard things like a smooth ride and easy handling.



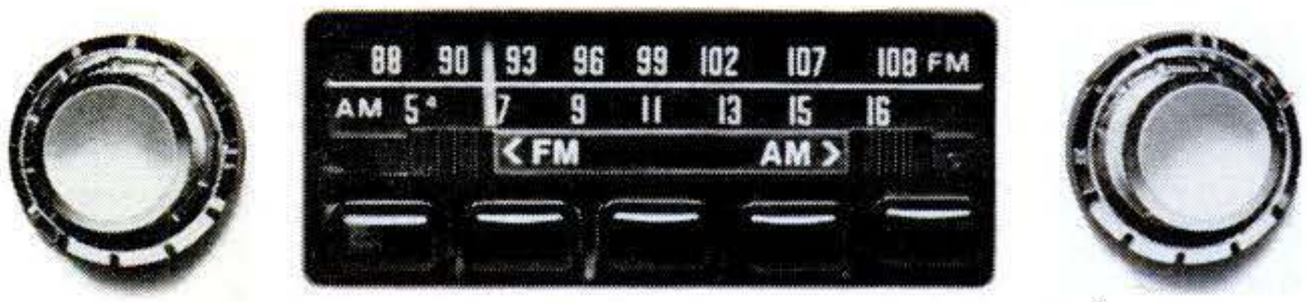
Optional air conditioning to keep you comfortable.

Optional color-coordinated interiors and exteriors, deep-pile carpeting and even a vinyl roof.



A Camper Special package that has everything you'd expect, like West Coast mirrors, plus some things you wouldn't expect: heavy duty front springs and shock absorbers; auxiliary fuel tank; power brakes and increased cooling.

Optional tinted glass.



Optional AM radio. Or, a step further: optional AM-FM radio.

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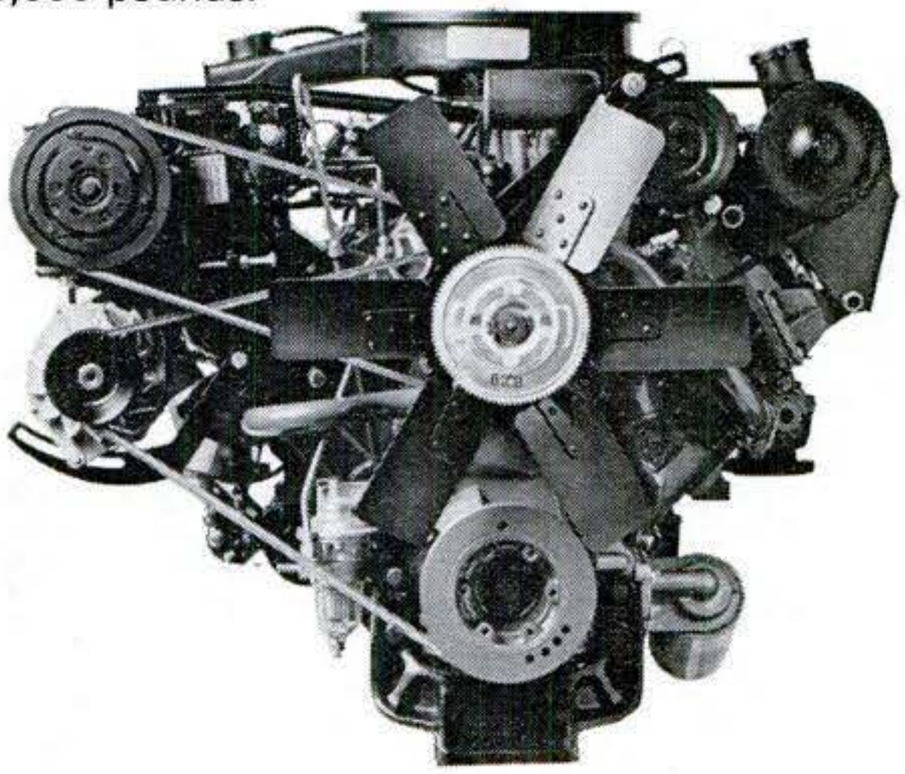

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The View Down the Road

...news and comment on cars and driving

By **JAN P. NORBYE** / *PS Automotive Editor*

Radial tires coming on strong

"By 1976, eighty percent of original-equipment tires in America will be of radial construction," predicts Firestone's Andrew Rodger Jr. Firestone has just added several new radials to its product line: Mini-Sport Radial for small imports, Steel Belt Radial for compacts, and the Radial V-1 for full-size cars. Firestone is rapidly expanding its radial-tire production capacity in both Canada and the U.S. The growing use of steel belts is particularly interesting. In the last year, Uniroyal, General, and Goodyear have also started making steel-belted radials. To make more of them, General is planning a new factory at Mount Vernon, Ill., as well as plant expansions in Mayfield, Ky., and Charlotte, N.C.

Electric cars you can buy

No less than four companies are now in production with electric cars designed for urban use. You know all about EFP of Detroit [PS, Feb. '71]. The latest EFP model is an Electrosport based on American Motors' Hornet Sportabout. The company president, Mr. Robert Aronson, claims a range of 50 to 100 miles on a charge, with 65-mph top speed. Batteries are lead-cobalt and can be recharged to 80-percent capacity in 45 minutes, he says. You'll have to be a true idealist to place your order: $11,900 is the sticker price.

The other new electric vehicles are the Vanguard, the Electro-Dyne, and a nameless design from Vehicle Research Ltd. in Canada.

The Vanguard is a utility vehicle built by Club Car Inc. of Augusta, Ga. It weighs only 960 pounds, seats two, has a cargo capacity of 250 pounds, moves at 30 mph with a range of 40 to 60 miles.

The Electro-Dyne is a 940-pound two-seater from Seal Beach, Calif. It is designed for local street use, and can be licensed by the state of California. Speed is low, only 25 mph, and range about 40-50 miles on a charge. It has the advantage of low cost: $1,850.

The Canadian prototype is built for 60-mph top speed, with a range of 30 to 60 miles on a charge. Built on an 80-inch wheelbase, it carries 12 12-volt auto batteries. The actual selling price of the vehicle will depend on how many orders they get. For production runs of 100 or more, this maker's price could come as low as $3,500.

More do-it-yourself repair stations

In April I told you about the U-Tune Centers in Michigan. This struck a responsive chord with many readers, and U-Tune seems headed for rapid expansion. I have also heard from Lou Dolgin in Van Nuys, Calif., operator of a similar establishment on the West Coast. His Auto Hobby Center in Van Nuys is equipped with tools, repair manuals, a staff of trained people to advise and assist, and the newest diagnostic analyzer. The Auto Hobby Center is open seven days a week and must be a real boon to do-it-yourselfers.

Machinery to mass-produce Wankels

Prototype GM rotary engines [PS, May] now running in Vega test cars were machined on a Tru-Coid grinder invented by Nils Hoglund, president of Tri-Ordinate Corporation in Berkeley Heights, N.J. There is only one job in manufacturing the Wankel engine that calls for new types of machinery—the task of grinding the epitrochoidal inner surface of the rotor housing. The Tru-Coid does this to a better than 10-micro-inch finish. It can work fast, with a programed electronic control unit supplied by Digital Equipment Corp. of Maynard, Mass. Development work on a mass-production version of the computerized system is being pushed.

The existence of such production tools should bring the few remaining auto makers not yet licensed to produce the Wankel to the negotiating table at Curtiss-Wright and Audi NSU Auto-Union AG. I would expect license agreements with Ford Motor Co. and Chrysler Corp. to be signed any day now. But they may not be able to get as favorable a deal as did GM 18 months ago ($50 million over five years for worldwide rights, no know-how sharing with other licensees, and no royalties). I would expect that Ford and Chrysler will have to settle for a royalty-type contract, with a sum to be paid for every engine built. How much? Rumors say the figures under discussion are three to five percent of basic engine cost. If the Wankel can be made at one-half to two-thirds the cost of a V8 of similar power, that kind of royalty won't be a serious deterrent. It can easily be absorbed (and passed on to the consumer).

Ahead of the callback campaigns

Dr. William Haddon of the Insurance Institute for Highway Safety keeps me informed of current NHTSA auto safety-defect investigations that may or may not lead to callbacks. Here are some of the things you may want to take a look at if you own one of the vehicles mentioned:

Risk of excessive heat buildup in the brakes of '71-model Olds Cutlass. Get your linings checked if you find signs of running hot.

Risk of separation of the steering tie rod on '71 Ford (Galaxie, etc.). Have your front end inspected.

Service aids of the future (and today)

Plug-in diagnosis is here, and will surely become general before long. Every '72 Volkswagen has built into it a service checkup system with a central socket which instantly relays service data on 22 different items ranging from compression to battery-water level. Now, Volkswagen is equipping its dealers with the plug-in computer to "read" the car's service status and needs. This is a marvelous initiative, which I think ought to be copied by all auto companies.

Leslie Hartridge in England, famous for its diesel pump testers, and a member of the Lucas group, has a slightly different approach.

The station computer is a modular design with a central unit that gives an actual print-out. If wired into a chassis dynamometer, the module with instrumentation for that is added. In all cases, there is an engine analyzer with four meters. In a vehicle prewired for analysis, four connections are made (contact breaker, battery, coil, and low-tension circuit to earth). If the car is not equipped with the necessary sensors and transducers, a multitude of connections must be made—but fairly simple ones.

What the VW and Lucas systems have in common is that both can be operated by unskilled mechanics. We are still suffering a shortage of skilled mechanics, and the solution may lie in taking the skill out of the job rather than in training new mechanics. With more and more electronic equipment coming into use on new cars, repairs are usually made by replacing units that then are returned to the manufacturer. There are fewer and fewer adjustment possibilities on the cars—when something is not working properly, you replace it. As this system spreads, it will build up a stock of service units (reconditioned) for replacement, and the cost may end up being less than paying The Model Garage for an expert diagnosis and a little technical trickery. PS

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The fishing spot acclaimed the best in the world . . . where the greatest variety of marine and freshwater fish are found: Black Marlin, Swordfish, Shark and enormous Lake Trout. Trip includes vacation stops in Hawaii and the Fiji Islands!

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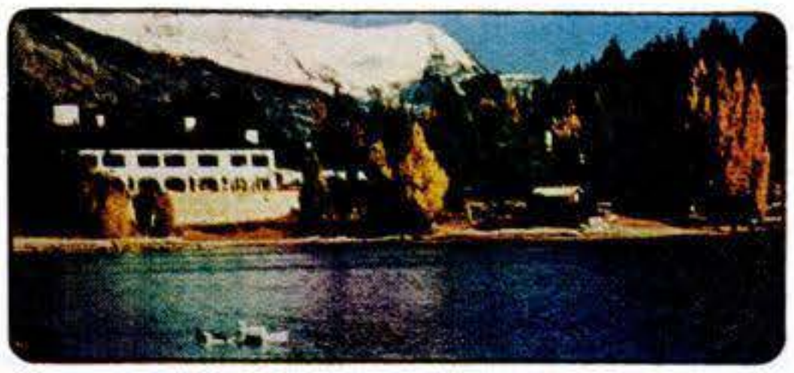
Fish from the top of the world . . . catch the largest fresh water fish known to man, the "Mahseer" of the Himalayas. Side trips to the Taj Mahal and Katmandu!

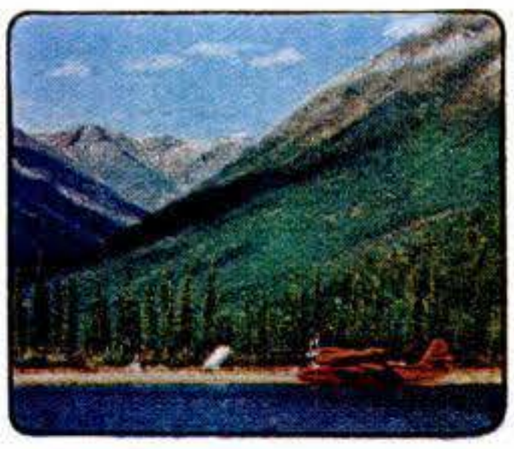


3rd PRIZE—2 WEEKS IN ARGENTINA

The uncrowded Argentine Lake District where huge Trout and landlocked Salmon abound — with a stay at the luxurious El Casco lake shore hotel and stopover in Buenos Aires!

4th PRIZE . . .
2 WEEKS IN URUGUAY

Fish for the famed "living torpedoes", the Golden Dorado. Trip includes visits to Buenos Aires, Montivedeo and the Riviera of South America, Atlantida Beach!



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To remote, inaccessible lakes where giant Dolly Varden and King Salmon await you, via special seaplane complete with personal guide!

6th PRIZE . . .
1 WEEK IN ENGLAND

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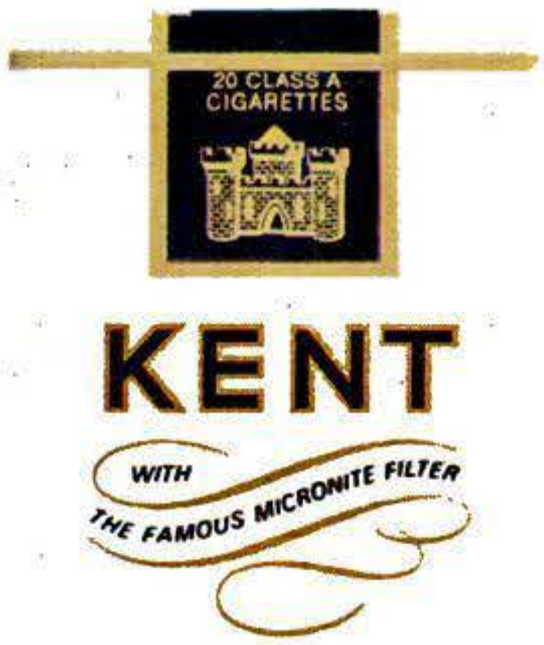

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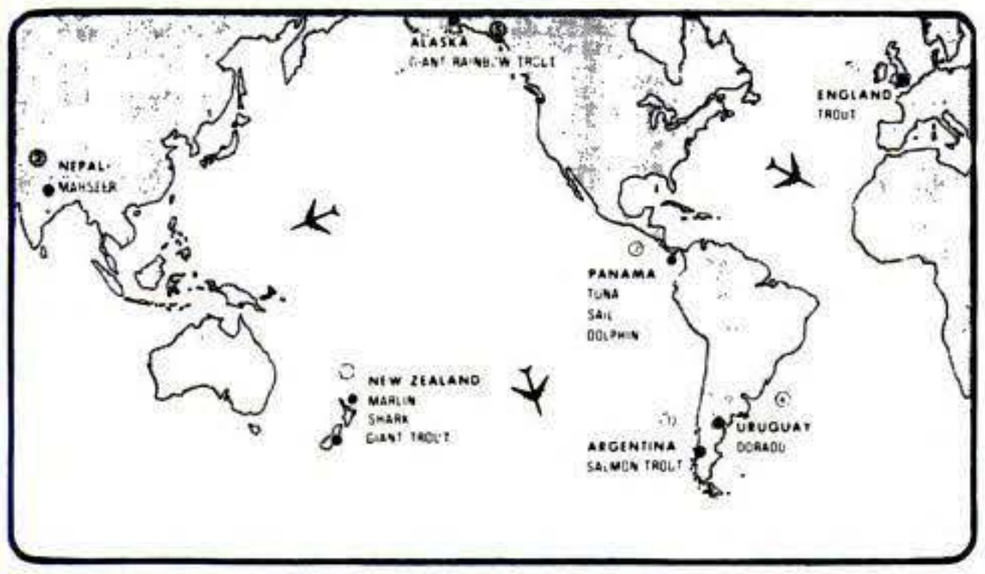
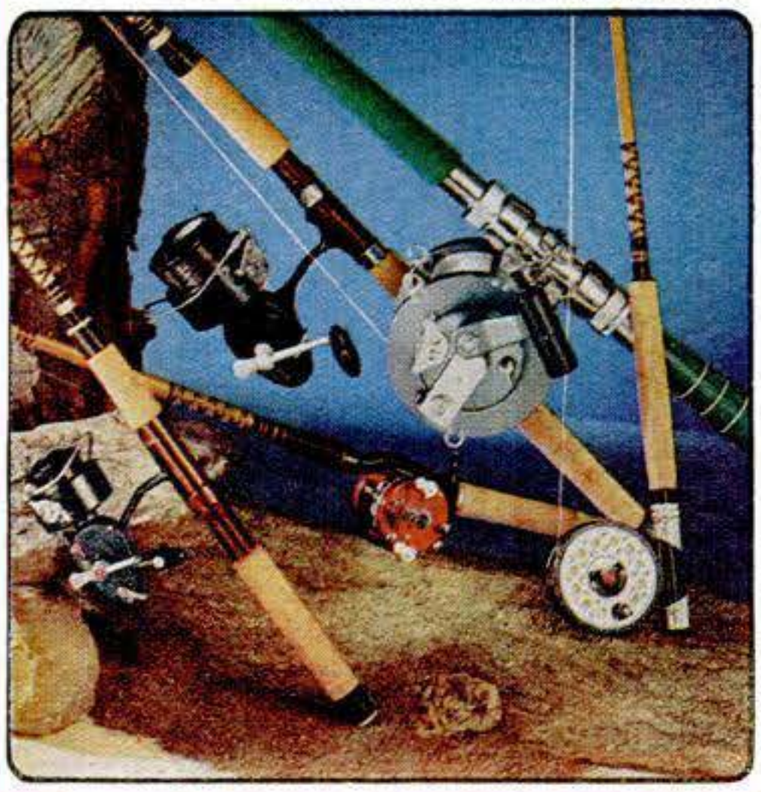


FISH THE 7 WONDERS WITH EXPERT EQUIPMENT FROM



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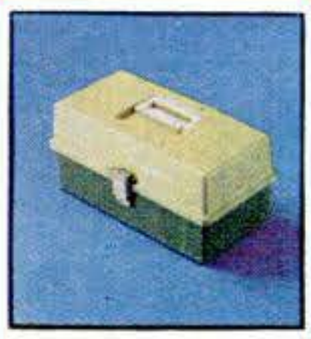

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All entries received by June 30, 1972 are eligible. All winners will be notified by mail. Enter as often as you like, but each entry must be mailed separately, use the entry blank provided here or a plain piece of paper the same size. Sweepstakes limited to entrants 21 years of age or older. Employees and their families of Lorillard, their media, advertising and sweepstakes agencies are not eligible. One prize to a family. No purchase required. If you are one of the 7 trip prize winners, and you list your dealer's name and address, he will receive a one-week fishing trip for two to Panama. Drawings will be conducted by D. L. Blair Corp., an independent judging organization whose decisions are final. No substitution for prizes. Payment of taxes on prizes is the responsibility of the winners and not Lorillard. Open to residents of the United States. Void in Idaho, Missouri, Washington, Georgia and wherever else prohibited by law. All federal, state and local regulations apply. For a list of major prize winners, send a separate, stamped, self-addressed envelope to: Fishing Winner's List, Box 963, Blair, Nebraska 68009. Entry in the sweepstakes constitutes full permission to publish names, addresses and photographs of winners without further compensation.

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Look and Listen

News, comment, and opinion from the world of home-entertainment electronics

By C. P. GILMORE

The plot thickens

Sony's U-Matic version of cassette TV [PS, Apr. '70] is now on the market. Cartrivision [Look & Listen, Apr. '72] goes on sale this month. Several Japanese firms are working on home TV recorder/playback machines, and there are a number of playback-only systems that have been demonstrated or announced [Look & Listen, Dec., Nov., '71, Mar. '72].

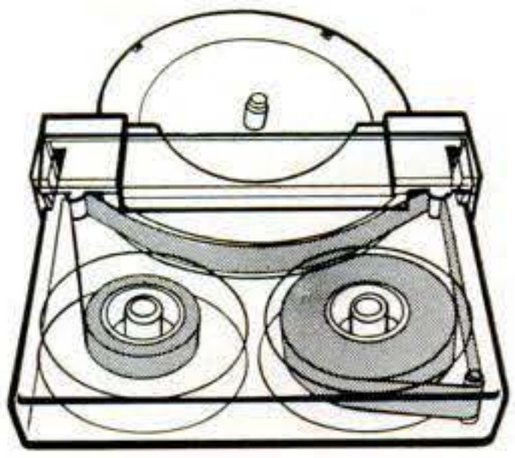
Now, RCA, which showed an elegant —but largely undeveloped — playback-only system based on holography two and a half years ago [PS, Dec., '69], has demonstrated yet another system. It's called SelectaVision MagTape, and will be on the market late in 1973.

I recently saw SelectaVision MagTape in action at RCA's consumer electronics division in Indianapolis. And I must say, while I think the field needs fewer rather than more entries, I was impressed. As you can see above, it's a handsome unit about the size of a stereo receiver. Shove a book-size (9"-by-6"-by-1½") cartridge in that slot on the front, push a lever, and it's playing.

Picture quality is excellent—to my eye as good as live TV. It is simple to operate, with no more controls than the average tape recorder. It has no tricky level adjustments or "fine-tuning" controls. It is completely compatible with all present sets; it plays into the antenna terminals. Since it has its own built-in tuner, you can watch one program while recording another. With its automatic timer, it will record programs while you're away from home. And finally, its projected price is $700—not cheap, but better than any present or projected system.

Of course, other companies have started out with low estimates, then raised prices as production neared. But I think RCA has a fighting chance of holding the price line. The reason: An ingenious new scanning system (held in the photo above by its inventor, H. Ray Warren) simpler and cheaper than anybody else's. The new scanner also offers certain advantages that will contribute to reliability and performance.

Most other systems pull the tape out of the cartridge during operation. That takes expensive, complicated difficult-to-align hardware. In the RCA unit, the scanner is shoved into the



cartridge—a far simpler approach (diagram). The scanner is cast and machined so that alignment is built in—no adjustments. Four heads on the periphery of a whirling disc move across ¾"-wide tape in a series of diagonal passes —the so-called helical scan system. Writing speed is 400 inches per second —enough to give a 2.5mHz band width and produce sharp pictures. Tape speed is three inches per second, so an hour's playing time takes just over 900 feet.

Tape isn't cheap; the cartridge will cost $30. But that, also, is lower than anybody else's. And you'll only need a reusable roll or two to catch TV programs for later playback.

RCA has invited virtually every major electronics manufacturer in the world to Indianapolis to see the unit. When I was there recently, several had accepted. RCA wouldn't say how many or who. But two—Bell & Howell, and Magnavox—had already signed licensing agreements to manufacture the units. Bell & Howell will make the tape transports both for itself and for RCA.

I wouldn't be surprised to see other manufacturers taking out licenses over the next few months. The RCA system is obviously a powerful new competitor in the videocassette field. Incidentally, RCA says it isn't abandoning its holotape approach either; it thinks the two systems will co-exist in the future. Within the next few months the company has promised to demonstrate the improvements it claims to have made to the holotape system since it let us have a peak in 1969. I'll be there and will report when I've seen it.

A really different videotape player

Digital Recording and Battelle Development are both working on a radically new system that reportedly records TV images in the form of digitally encoded electrical signals on photographic film. The information-storage density of film is so high that a 30-minute color program could reportedly be recorded on a 4"-by-5" piece of film which costs about 50 cents. No details yet on just how the system works—how it transforms the picture into electrical signals, records them on film and plays them back, for example. But if it proves to be practical, it might give the entire video-recording business a new twist.

On the four-channel scene—

RCA has just announced that its first discrete four-channel discs [Look & Listen, Feb.] will be on the market by the time you read this. They'll cost the same as regular stereo discs, unlike Columbia SQ encoded records, which go for a dollar more than standard stereo. The RCA records will be completely compatible; they'll sound as good as current stereo records when played on a good-quality stereo machine.

The biggest problem with the four-channel disc originally developed by JVC, was that rear channel information was recorded in the groove on a high-frequency carrier signal. Playing the record several times tended to wipe most of the high-frequency wriggles out of the groove. Now RCA says it has developed a revolutionary new self-lubricating material that doubles record life and overcomes this problem. And a much more sensitive demodulator (about $80) has been developed that will make the records playable with a regular high-quality stereo cartridge. High-fidelity fans will probably want to use the special cartridge designed for the system for the best possible reproduction. Four-channel equipment for playing the new RCA discs will be manufactured by Panasonic and JVC; RCA will make records but hasn't yet announced whether it will also make playback hardware.

Continued

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Look and Listen

[*Continued*]

Standardization?

Potential buyers of four-channe equipment are trapped by the matri vs.-discrete squabble. And if they decid to go the matrix route, they're wonde ing which of several systems will wi

Now, the Electronics Industry As sociation has proposed that its mem bers agree on standards for four-channe FM broadcasting. To do that, they' have to get into the discrete-vs.-matri argument, and the which-matrix-is-bes squabble as well, since the group woul have to pick a system before it could de cide how the signals should be transmit ted. The very idea of standardizatio has—as you might guess—caused a bi argument. A consensus would take mor compromise and consideration for th consumer than the industry usuall shows. But if they can do it, we'll b better off.

On the record—by Ken Furie

On the whole, the discs and tapes I heard this month were not an inspiring bunch. But there were some good ones:

Saxophonist Eugene Rousseau has somehow scraped up four *Concertos for Saxophone* (DGG). The music—by Glazunov, Villa-Lobos, Ibert, and Pierre Max Dubois—is surprisingly interesting; Paul Kuentz and his chamber orchestra give fine support; sound is first-class.

Two familiar singers are busily establishing new identities, as you can hear on a pair of quaintly titled releases: *Paul Simon* (Columbia) and *Cass Elliot* (RCA). The Garfunkel-less Simon and de-Mama-ed Cass now offer the latest rock sounds. Both sound a bit over-earnest, but it's good to hear them again. I heard both disc and cassette of *Cass*; not much to choose between them soundwise with this simple material.

Leontyne Price has recorded actively for over 10 years, but *Five Great Operatic Scenes* (RCA) may be the best thing she's done. The program is awesome: magnificent scenes from *Traviata*, *Eugene Onegin*, *Don Carlo*, *Fidelio*, and *Ariadne*. The recorded sound is dullish, the accompaniments rather poky. But Price has never sounded better.

Review by Arthur Fisher

Maybe you didn't get to the concert, and you can't take the new movie home, but you can buy a three-disc album of *The Concert for Bangla Desh* (Apple). The concert was held last August at New York's Madison Square Garden to raise money for the child victims of the war in, then, East Pakistan. Under the guruhood of George Harrison and Ravi Shankar, a joyous noise was raised in the Garden, and it's all here: Bengali modes by Shankar and Ali Akhbar Khan, rock numbers by Harrison (including *Wah-Wah*, *Something*, and *Bangla Desh*), old Dylan standards by Dylan (including *Mr. Tambourine Man* and *Blowin' in the Wind*), a number by Ringo Starr, and much, as they say, much more. The night's excitement comes across in good clear sound. PS

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He's listed in your phone book under U.S. Government, Navy, Dept. of.

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Send To: Captain Donald E. Oglevee 11
Building 157, Fourth Floor,
Washington Navy Yard,
Washington, D.C. 20390

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A test of three winners: Capri V6 in the background is flanked by the Fiat 124 Sport Coupe (left) and the Datsun 240/Z (right).

NEW SPORTS IMPORTS: Tops in Braking and Handling

We call them sports cars, but their space, versatility, and finish qualify them as family cars, too

By **JAN P. NORBYE** / *PS Automotive Editor* **and JIM DUNNE** / *PS Detroit Editor* PHOTOS BY DAVE HOUSER

One look tells you they're sports cars. Or perhaps you prefer to call them GT (Grand Touring) coupes. Both labels fit perfectly. The three cars set new records in our braking and handling tests, accelerated right along with some of the biggest American V8s you can buy, and surprised us with their gasoline mileage. Yet these cars are much more than just sports cars. They are excellent automotive value, and can fill a number of needs.

Family cars. If two-plus-two seating is enough for your needs, the Capri and Fiat can be used as family cars. They have roomy front seats, and small but usable back seats. The Datsun is strictly a two-seater. Certainly, if you think in terms of driving pleasure rather than of extra-load and seating capacity, you could well choose one of these sports models for all-around use.

Personal luxury cars. To those who feel that cars in the Riviera/Thunderbird class have grown too big and too heavy, these may be a logical alternative. You won't be giving up much luxury, for these little coupes have fine interior finish and trim. What they don't have is a lot of power-operated gadgets and useless decor items. Their more-functional instrumentation may also appeal more to the true auto enthusiast.

Economy cars. They look like anything but economy cars, and the prices, while quite reasonable in our judgment, are not cheap. So how can we justify calling them economy cars? If you are more interested in low upkeep and running costs than in initial purchase price, they could save you money. Their quality is evident from their total reliability during our entire test program, and their 25-plus gas mileage beats many smaller and cheaper cars.

Safety cars. Like all other '72 models, they meet current federal safety standards. But they go way beyond that. Not in terms of crash protection [turn to "The Race to Build the World's Safest Car"], but in terms of accident avoidance.

Their stopping power brings them to a halt in distances so short as to be flirting with the limits of the laws of physics. And remember that stopping just 30 feet shorter can make the difference between hitting an obstacle at 25 mph and not hitting it. The evasive ability built into these cars is phenomenal. They are balanced and completely predictable in their road behavior. In terms of active safety, these cars are the best we have tested.

As sports cars or GT coupes, they're tops, too. What excites us most about them is the fun of driving them—the way they respond to a small movement of the steering wheel, a well-timed shift, a touch on the brake pedal. They reward you well for your driving skill, yet they do not demand much skill from an inexperienced driver. They are very easy, and excellent, to learn on—safely. For people who refuse to shift for themselves, the Capri and Datsun can be had with automatic transmission.

Capri V-6 2600. This is the latest version of the most popular model ever produced by Ford of Germany.

Continued

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17 mg. "tar," 1.2 mg. nicotine av. per cigarette, FTC Report Aug. 71.

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Fiat 124 set record for brake-fade resistance, came close to best-ever stopping distance.

Capri suffered some rear wheel locking in brake test and in our test was not fade-free.

Datsun rivaled Fiat for braking excellence; stopped even shorter with cool brakes.

Lane-change test measures high-speed maneuverability. Lanes are blocked 120 feet apart; cars make double lane change.

Datsun proved very steady, with slight roll but almost neutral steering.

Capri had biggest tires, least roll, and instant and accurate response.

Fiat was fastest, with some understeer, slight roll, very precise steering.

At a list price under $3,000 it is a bargain. You'll find a well-finished interior, with full instrumentation, carpeting, center console, bucket seats with reclining backrests, fold-down armrest in the rear, assist straps for the passengers, all-vinyl upholstery and soft trim, upper-level ventilation. A closeable glove box is missing—you must use an open tray below the dash, half the width of the panel.

Seat-back release levers proved very balky in action, a major inconvenience when getting in or out of the back seat. Front-seat belts are coiled on the rear-seat floor in an awkward position and can't be fastened with doors closed. Trunk room is great for a car of this type, with a wide, flat loading area. The spare wheel stores under the trunk floor, in an easy-to-reach position.

Underhood accessibility is disappointing. The left-rear spark plug is hidden below the power brake booster. The oil filter is accessible only from under the car. And the distributor is placed close to the firewall in a hard-to-reach position. Like the others, there's an inside hood-lock latch, but the hood opens at front (alligator fashion).

The four-speed all-synchromesh transmission proved fairly quiet, but the gate gives an uncomfortably long throw to third gear, and reverse (next to second) has no lockout. The steering has great precision, but demands quite high muscular effort—no problem for a man but a drawback for a woman.

Datsun 240/Z. Built in Japan by Nissan Motors, the second-largest auto maker in that country, the 240/Z comes to the American market at a little over $4000. And what a package! It's a sports car that puts it all together—top quality and exceptional attention to detail; up-to-date styling; secure seating arrangement; excellent power train, suspension, and brakes; full instrumentation; convenient size—all at a realistic price.

Continued

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Pete Brock's Champion cars: How to get one.

In the foreground, Pete Brock's Trans-Am Champion Datsun sedan. With enough cash you can persuade Brock Racing Enterprises to build you an exact copy, complete with Champion Spark Plugs.

In the background, Pete Brock's SCCA two-time Championship Datsun 240Z. You can easily persuade us to send you a 1/25 scale model kit (including full-sized Champion, Datsun and Valvoline racing decals) by sending us $2.00.

In between, Pete Brock. Unfortunately there are no copies of Mr. Brock.

Mail to:
Champion's Datsun 240Z
P.O. Box 38, Troy, Mich. 48084
Gentlemen: Please rush the fabulous Revell kit of Pete Brock's Datsun 240Z and decals. I enclose $2.00.

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City_____ State_____ Zip_____

Offer good only in U.S.A. Allow 4 weeks for delivery.

20 million people have switched to Champion Spark Plugs.

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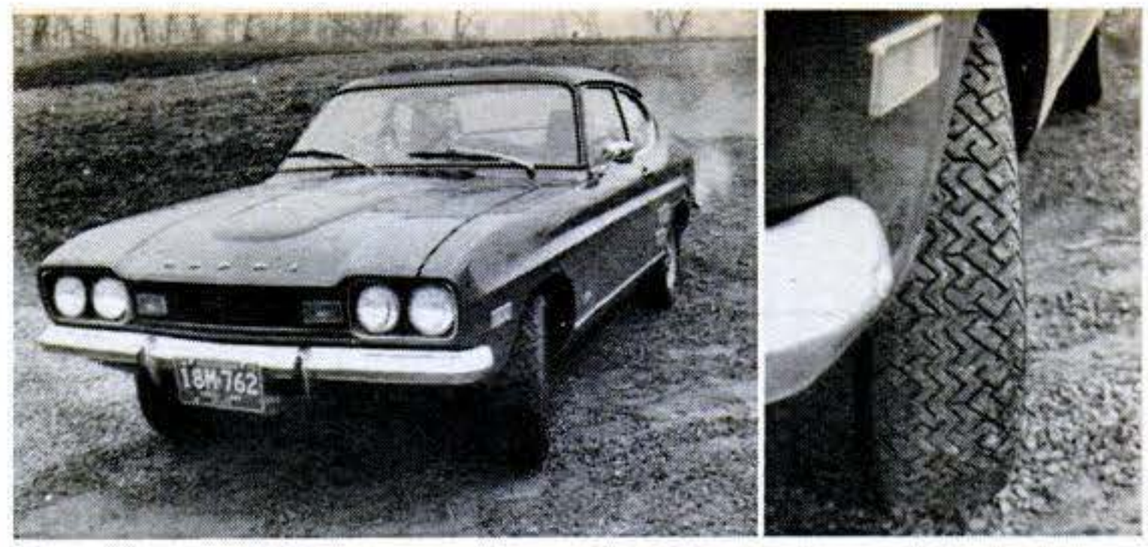
Six-cylinder Datsun had best fuel economy. One-gallon tank (on right-door window) gave over 27 miles at constant 45 mph.



All-rayon Pirelli radial tires on Capri have coarse tread pattern, very wide footprint, and low noise level.

Fiat's Goodyear radial tires, made in Italy, displayed surprising adhesion despite their fairly narrow footprint.

Japanese-made Toyo radials on the Datsun have low rolling friction, yet they give terrific traction and sidebite.

A short-throw positive four-speed stickshift, ideally placed, is combined with a smooth clutch. You'll find the small controls in handy positions, too. Lights, wiper, and washer switches are at fingertip reach on a stalk at the right of the steering column. Instruments? Speedometer and odometer, tach, temperature, oil, amp, fuel, and clock.

High-level ventilation is provided by individual vents at either side of the instrument panel, with an additional cool-air grille at the center of the panel. Well-shaped bucket seats have recliner mechanisms. A feeling of safety in the car is heightened by a heavily padded dash and a long hood.

The rear hatchway has an enormous window, equipped with wires for defrosting. The storage area behind the seats is very roomy, easily reached from the hatchway. The spare wheel is stowed under the floor, in a clean, dry place, readily at hand.

The tall, straight six-cylinder engine is simple to work on for routine maintenance. Plugs sit high up on one side, with the oil filter below. The twin carburetors are out in a relatively open area. The fuse box is in the console inside the car, with all fuses labeled.

Fiat 124 Sport Coupe. Built in Italy by a company that makes close to two million cars a year, this Fiat sells here for about $3,600. With its little twin-cam four, does it really belong in such fast company? We find the answer an unequivocal *yes*. The little engine is so willing to rev that Fiat comes close to matching the sixes on acceleration—aided, of course, by the five-speed stickshift. In return, it gives no better fuel economy than the sixes.

It is in handling and braking that the Fiat excels. It set an all-time high in our lane-change test, proving better accident-evasion capability than hundreds of cars of all types tested by us in the past five years. The Fiat also has lighter steering than the two six-cylinder cars.

The brakes? It's the only car with disks on all four wheels, and a weight-sensitive brake-force distribution valve to restrict rear-wheel line pressure under severe braking. Stopping distances were ultrashort, pedal pressure remained unaffected by heat, and fading never occurred. On top of that, there was no brake squeal or other noise.

Standard equipment on the Fiat includes an air horn and wiper/washer controls in easy reach, adjustable within a wide stepless speed range, with intermittent wiper action when desired. A new dimmer switch (in the same place, below the turn-signal stalk) switches only between high and low beam, with parking lights selected by the dash-mounted light switch. Instrumentation includes tach, oil pressure, temperature. Doors have vent windows, and upper-level ventilation is provided.

Individual front seats recline to flat position. Back-seat comfort is comparable to that in a two-door sedan. All passengers have armrests; passengers in rear have assist straps. There is no glove box, but there are storage bins in the kick panels on both sides. The trunk is unusually large for a sports car. The spare wheel is stored below the trunk floor, next to the fuel tank.

Access to the engine is great. The distributor rises above the cylinder head; the plugs stand straight up between the cam covers. The oil filter can be removed from above, and the cooling system is sealed.

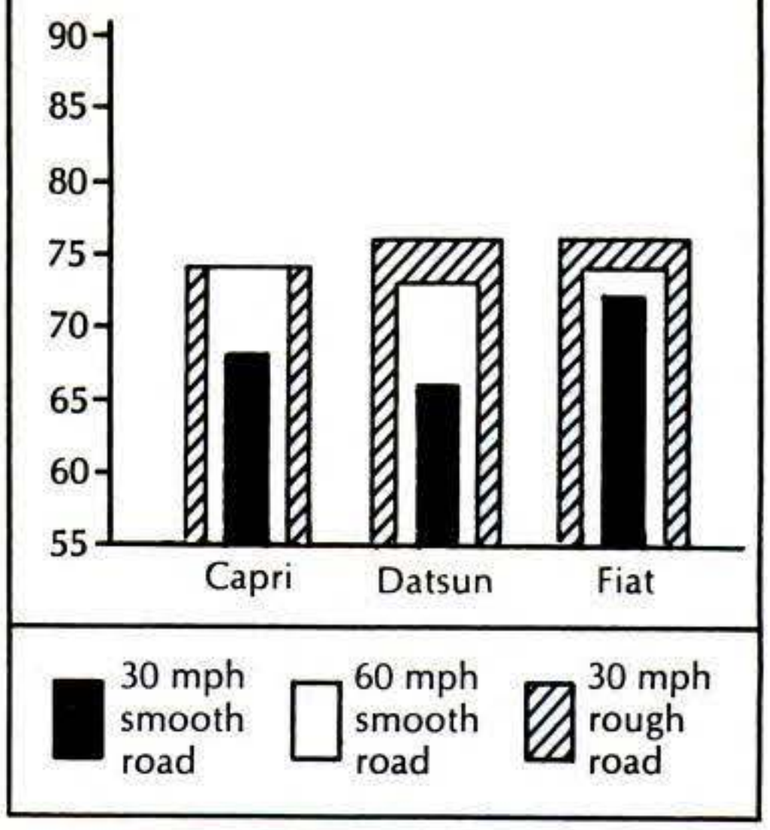
Conclusions

These cars differ widely in price,

Continued

NOISE-LEVEL TESTS

We measure interior noise in decibels under three sets of conditions, on three different scales. For quick reading of the results, we give you only the A-weighted scale, which is most like human hearing in overall sound pickup. A decibel difference of one or two points is perceptible to a driver; five points make enormous difference.



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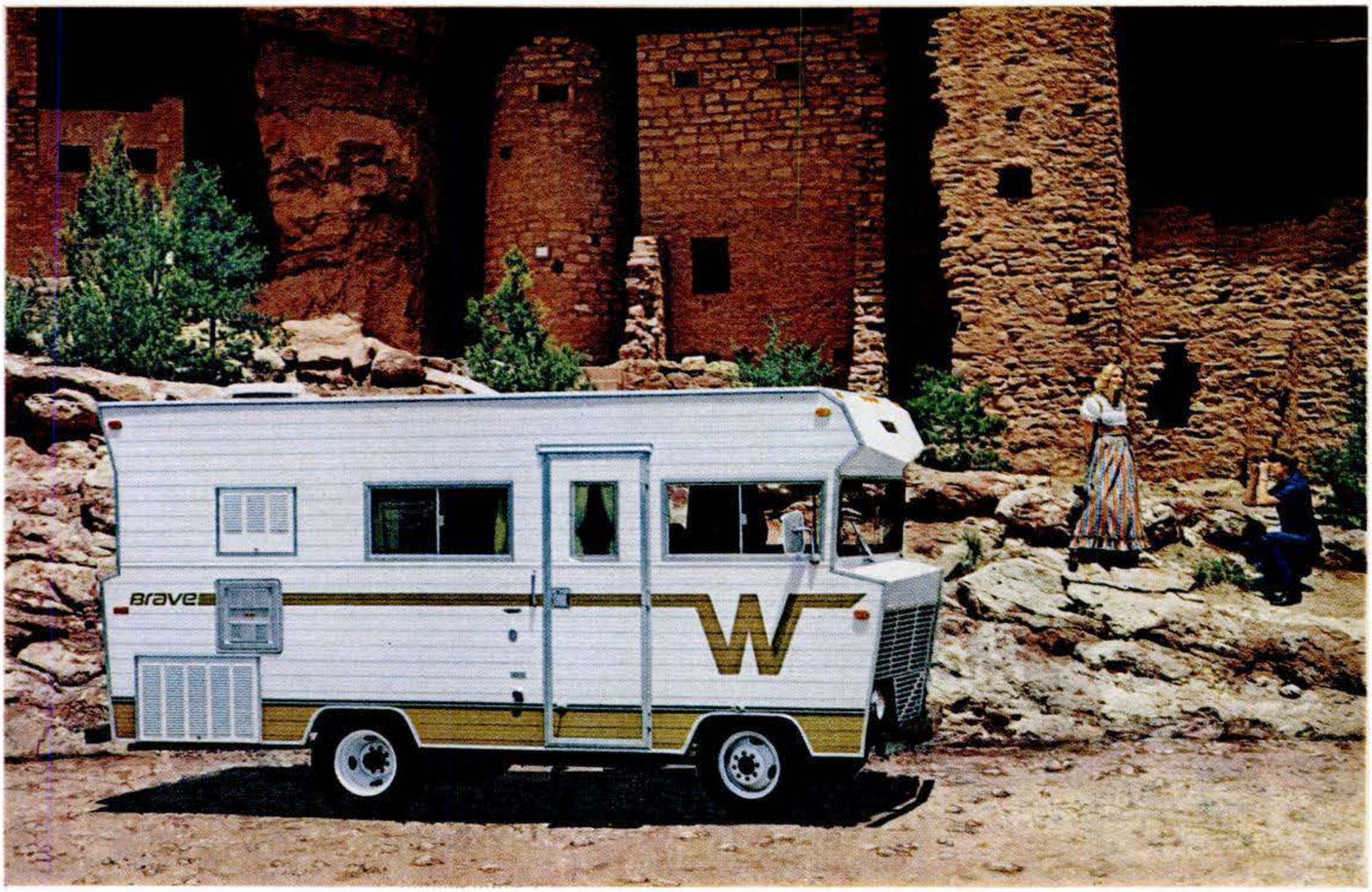
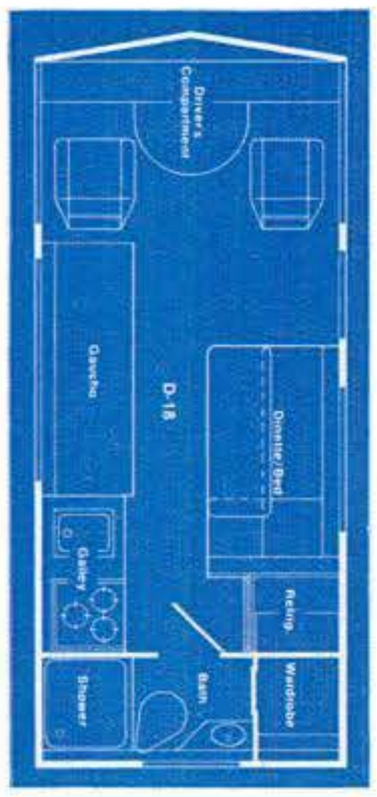


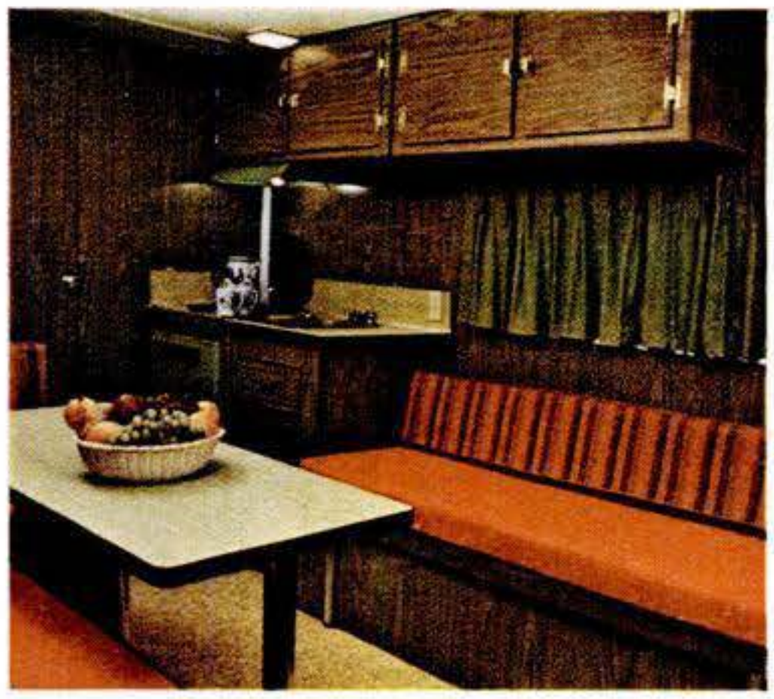
$6,700* Feature for feature and dollar for dollar, it's your best buy in a low-cost motor home.

Maybe you'll find a motor home with a lower **sticker price** than Winnebago's new D-18 Brave. But if you do, compare the standard equipment. Then start adding up all the **extra** money you'd have to spend to bring the other unit up to Winnebago quality.

The new D-18 is compact and easy to drive—at 18'3", it's no longer than a family station wagon. It has a big 318 cu. in. Dodge V-8 engine with power brakes, power steering, automatic transmission and dual rear wheels. It's built with exclusive Thermo-Panel® construction. Yet it's priced at just $6,700*. And it includes dozens of standard equipment features that are either not available or optional at extra cost on most other low-cost motor homes. Features like water heater and shower, pressurized water system, forced-air furnace, 3-burner stove with oven, 4 cu. ft. gas/electric refrigerator, dual 70 amp. batteries, twin 20-lb. gas bottles and 15 amp. converter.

See the D-18 Brave and 9 other 1972 Winnebago motor home models at your dealer's now. Or write to Winnebago Industries, Inc., P. O. Box 152, Forest City, Iowa 50436. This is the year to find out how much fun you can have when you go the Winnebago route.





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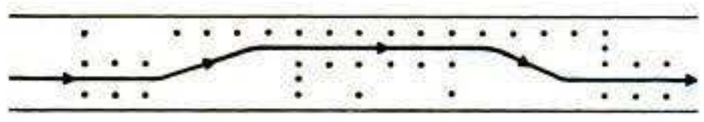
How other small cars fared in our tests

CAR	CHEVROLET VEGA	DODGE COLT	FORD PINTO	GREMLIN	1971 HORNET 6	MG B	OPEL GT	OPEL 1900	PLYMOUTH CRICKET	TRIUMPH GT 6	TRIUMPH TR 6	VOLKSWAGEN SUPER BEETLE
Accel. 0-60	15.7	14.2	16.8	14.7	16.2	16.0	13.9	15.1	22.2	12.5	13.4	19.5
Accel. 0-80	31.8	27.2	36.1	31.5	29.9	28.0	24.9	27.8	—	23.0	25.0	44.0
Accel. 25-70	19.4	15.8	20.8	17.2	18.3	17.5	15.0	17.3	30.4	13.3	14.4	27.3
Brakes 60-0 (hot)	143.0	152.5	132.9	134.5	182.0	197.3	158.3	129.6	150.6	182.9	162.0	126.6
Lane change (mph)	60.0	60.0	61.2	60.0	53.0	57.8	60.0	54.5	56.3	58.2	57.8	58.2
Slalom (mph)	26.8	27.6	27.6	26.8	22.2	27.0	28.6	29.1	27.2	26.4	26.4	27.6
Fuel mpg (45 mph)	21.1	28.5	21.0	21.5	14.9	15.6	17.4	25.3	24.3	17.7	17.2	30.1
Noise (60 mph)	76 dbA	76 dbA	76 dbA	71 dbA	74 dbA	—	—	71 dbA	80 dbA	—	—	77 dbA
Price	$2,703	$2,385	$2,966	$2,940	$2,584	$3,287	$3,670	$2,348	$1,915	$3,065	$3,417	$2,049

How PS tests cars—and what the tests show

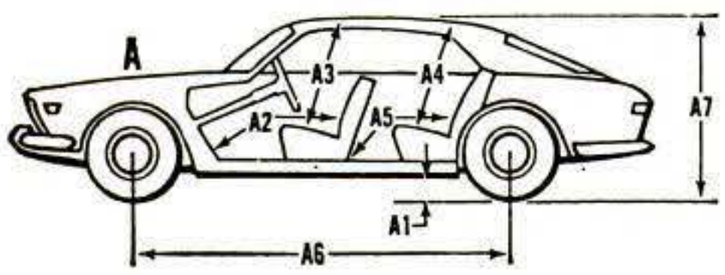
Brake test shows a car's ability to stop from 60 mph without wheel locking. Test is first made with cool brakes, then repeated after 10 warmup stops from 60 at one-minute intervals with 0.5g deceleration. First test shows braking capacity, balance; the second, fade. Excessive pedal pressure indicates fade. Excessive distance indicates fade, incipient or partial locking, or combination of both.

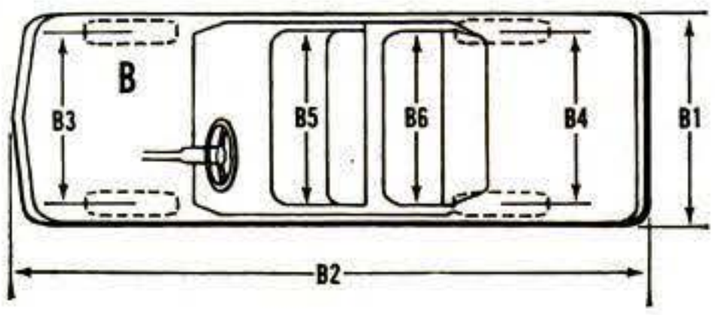
Acceleration test at 0-60 mph shows a car's ability to reach cruising speed from standstill. The 0-80 mph test shows its high-speed power reserve; 25-70 mph test simulates a highway merging situation. Cars with automatic transmission are tested in DRIVE.



Two lane changes in quick succession show a car's ability to make an emergency maneuver at speed. Lanes are blocked 120 feet apart, and lane-change gaps are 60 feet long. Each car is put through test at increasing speed until its maximum is established.

Low-speed emergency maneuver test means snaking a car as fast as possible through pylons 48 feet apart. In both handling tests, times clocked by two stopwatches are converted to mph.

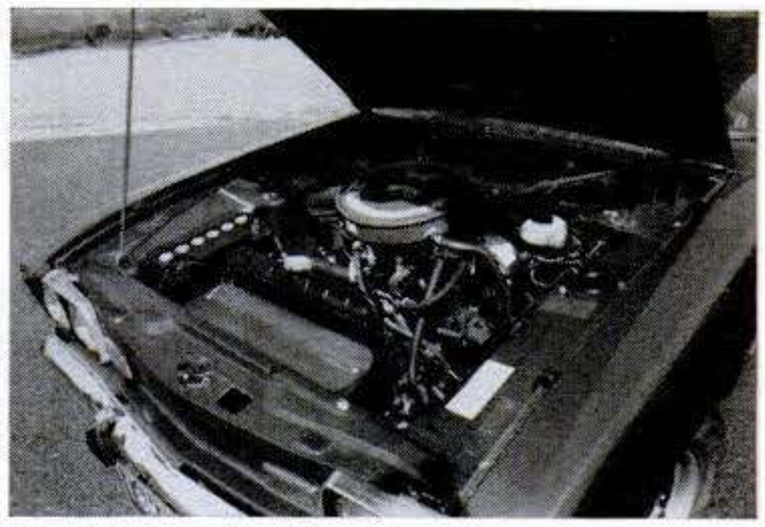




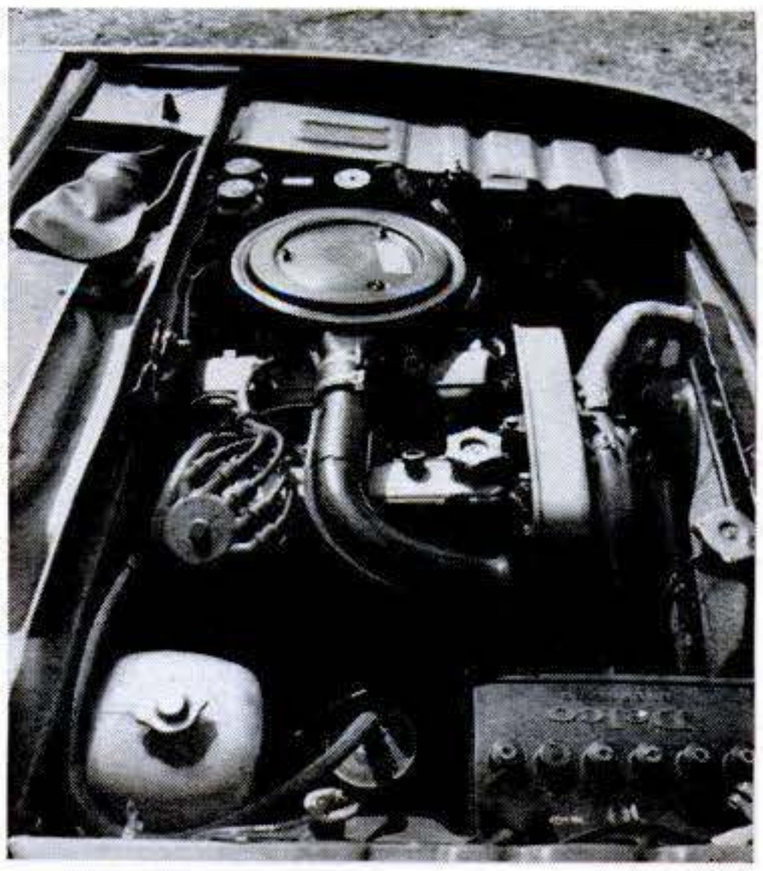
	CAPRI 2600	DATSUN 240/Z	FIAT 124 SPORT COUPE
DIMENSIONS (inches)			
A1 Ground clearance	5.0	5.7	4.8
A2 Front leg room (max.)	45.5	48.0	45.0
A3 Front head room	37.0	34.5	36.5
A4 Rear head room	30.25	---	31.3
A5 Rear leg room (min.)	33.0	---	32.6
A6 Wheelbase	100.8	90.7	95.3
A7 Height	50.7	50.5	52.7
B1 Width	64.8	64.1	66.7
B2 Length	167.8	162.8	164.0
B3 Front track	53.0	53.5	53.0
B4 Rear track	52.0	53.0	51.8
B5 Front hip room	22 (×2)	22 (×2)	22 (×2)
B6 Rear hip room	50.5	---	50.0
SPECIFICATIONS			
Engine type	OHV V6	SOHC in-line 6	DOHC in-line 4
Displacement (cu. in./cc)	155.7/2,595	146/2,393	98.1/1,608
Compression ratio	8.2:1	9.0:1	8.5:1
Carburetion	One 2-bbl.	Two 1-bbl.	Two 2-bbl.
Net hp @ rpm	107 @ 5,000	110 @ 5,600	94 @ 6,600
Net torque @ rpm	130 @ 3,400	124 @ 4,400	94 @ 4,000
Transmission	4-sp. manual	4-sp. manual	5-sp. manual
Axle ratio	3.22:1	3.4:1	4.10:1
Tire make	Pirelli	Toyo	Goodyear
Tire type	Cinturato	Radial Z-1	G800
Tire size	185/70HR13	175HR14	165HR13
Turn diameter	34.0 ft.	31.4 ft.	34.5 ft.
Turns, lock to lock	3⅓	2¾	2¾
Brakes	Disk/Drum	Disk/Drum	Disk/Disk
Fuel tank (gal.)	12.0	15.9	11.4
Trunk cu. ft./liftover in.	7.0/30.5	8.5/31.0	8.9/30.75
Curb weight (lbs.)	2,293	2,312	2,245
TESTS RESULTS			
Acceleration 0-60 mph	9.6 sec.	10.1 sec.	13.6 sec.
Acceleration 0-80 mph	18.1	19.05	25.6
Acceleration 25-70 mph	11.9	12.8	15.2
Braking (cool) 60 0 mph	136 ft. 11 in.	111 ft. 2 in.	115 ft. 4 in.
Pedal pressure	120 lbs.	140 lbs.	140 lbs.
Braking (hot) 60-0 mph	169 ft. 1 in.	122 ft. 1 in.	121 ft. 6 in.
Pedal pressure	120 lbs.	200 lbs.	120 lbs.
Max. speed—lane change	64.7 mph	65.0 mph	70.0 mph
Max. speed—slalom	30.1 mph	29.1 mph	29.1 mph
Gas mileage (constant 45 mph)	27.651 mpg	27.668 mpg	26.655 mpg
Price (basic)	$2,821	$4,106	$3,563
Price (as tested)	$2,996	$4,174	$3,626

and it would not be fair to single out one for special recommendation. All three are winners. We recommend them highly. We think the Datsun will prove most attractive to Corvette owners who want something smaller and more practical. And the Capri should prove attractive to Mustang buyers.

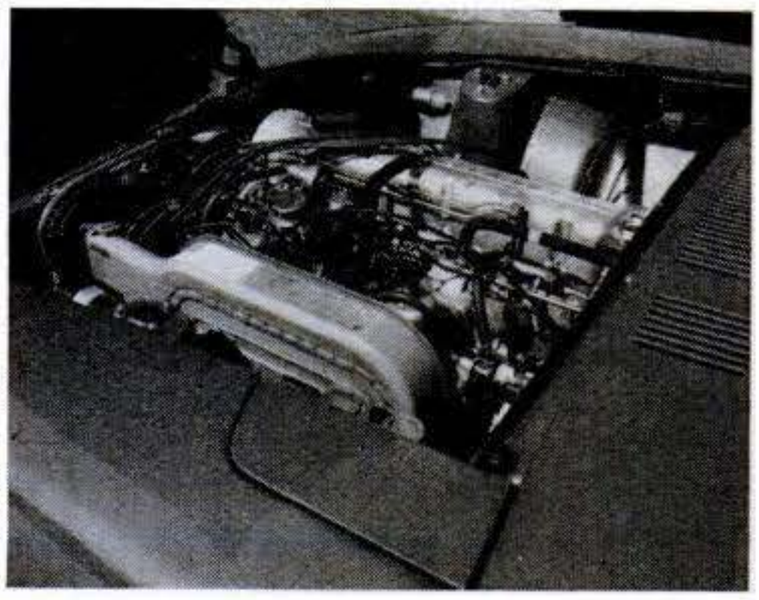
The Fiat could well be the choice of Sports Car Club of America types who are looking for a truly modern, advanced, and comfortable machine equally suitable for rallying and commuting. All three are backed up by strong service and parts organizations: Capri is handled by 2,500 Lincoln-Mercury dealers; both Fiat and Datsun have over 600 dealers and a nationwide distributor network. PS



Ford V6 pushrod engine fits snugly under the Capri's hood (hinged at cowl).



Double-overhead-cam four-lunger powering Fiat has excellent service accessibility.



Single-overhead-cam Datsun six is well finished, easy for mechanic to work on.

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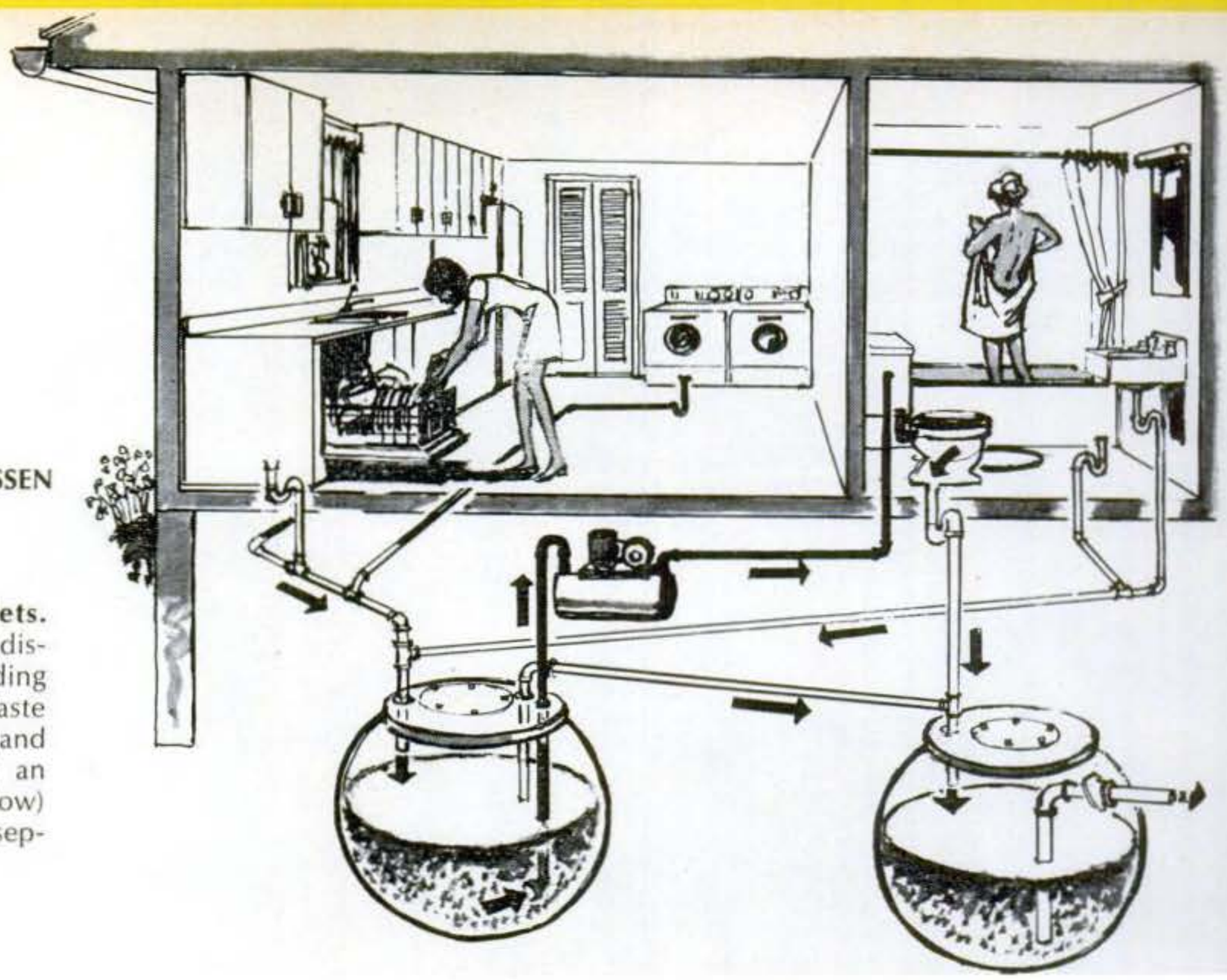
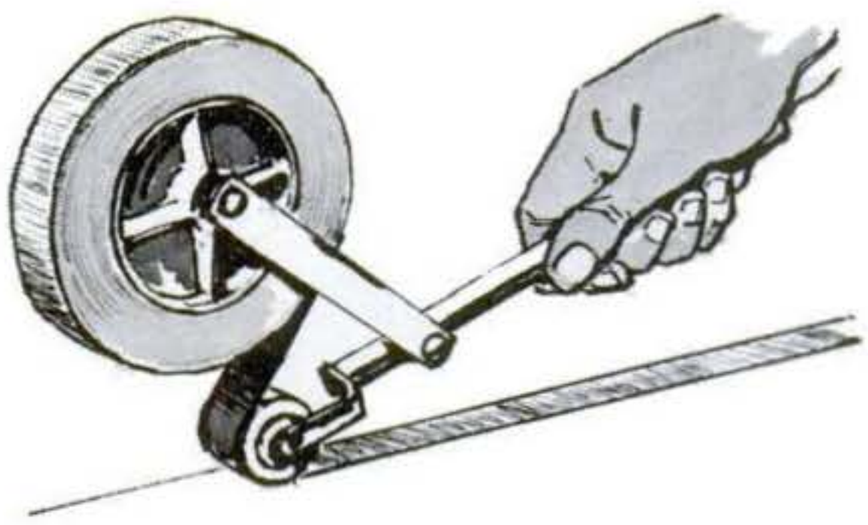
New Ideas from the Inventors

ILLUSTRATIONS BY DANA RASMUSSEN

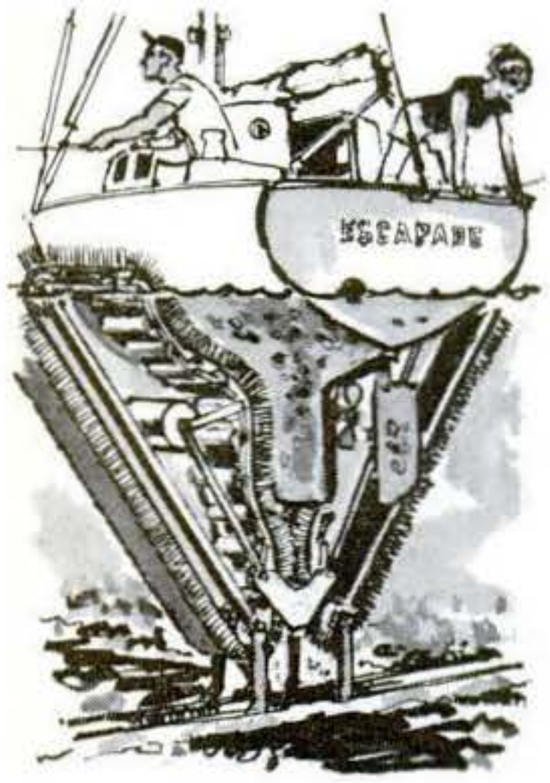


Filtered waste water flushes toilets. Household water consumption—and discharge—could be cut in half, according to this recent patent, by reusing waste water to flush toilets. Kitchen, bath, and laundry drainage would collect in an aerating tank. Flush water (and overflow) from this tank would drain into a separate disposal system.

Jets "enlarge" pool. With pressurized nozzles creating a stiff but stabilizing countercurrent, a swimmer could practice or exercise in a small pool. The stream's force, diminished by distance from the jets, would hold him stationary when he matched his stroke to pool position.



Roller applies tape. Guided by the edge you want protected, this roller would lay down masking tape while keeping the long strip from tangling. In line with the feed reel, the roller would draw off tape and press it down. Spacers would adjust the tool for tape width.



Brushes scrub boat. Rotating brushes would clean the hull of a boat as it was towed, by a conveyor, through this underwater scrubber. Sensors would tilt and adjust the brushes to the hull's contours. By eliminating costly time-consuming hauling, the scrubber might permit more frequent cleaning and prevent fouling of a hull by barnacles.

Rack winches spare. Clamp the spare wheel of a van or pickup in this railed, pivoted support, and it could be cranked down from its storage position under the body. Moving it into alignment with the axle would make it possible—or easier—for one man to mount it. When cranked up, the hoist would be locked against tampering to prevent theft.

The following patents have been issued on these inventions: **Water saver**—*No. 3,543,294 to Carl F. Boester, Arlington, Va.;* **Swimming-pool jets**—*No. 3,534,413 to Prosper P.Y.R. Plasseraud, St-Cloud, France;* **Tape applicator**—*No. 3,537,942 to George J. Kefalos, Barberton, Ohio;* **Underwater boat scrubber**—*No. 3,541,988 to Henry J. Laney, Berkeley, Calif.;* **Spare-wheel rack and hoist**—*No. 3,539,152 to Harley D. Paul, Martinez, Calif.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner.

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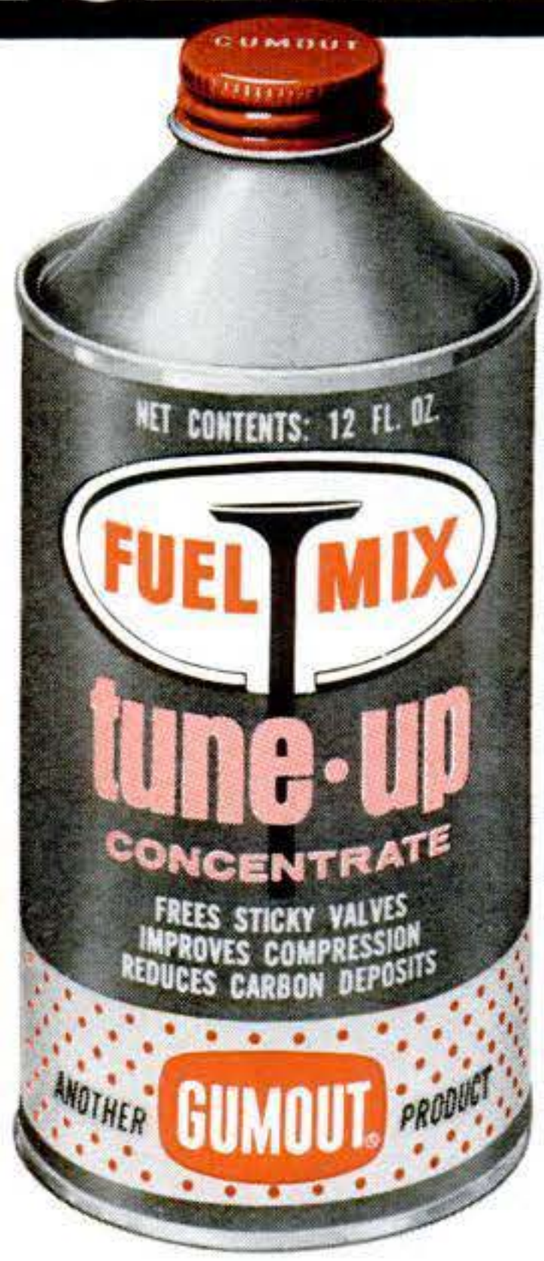
Marlboro Red
or Longhorn 100's—
you get a lot to like.

Kings: 20 mg. "tar," 1.3 mg. nicotine—
100's: 22 mg. "tar," 1.5 mg. nicotine av. per cigarette, FTC Report Aug.'71

KNOCKING, PINGING, SLUGGISH ENGINES NEED FUEL MIX.

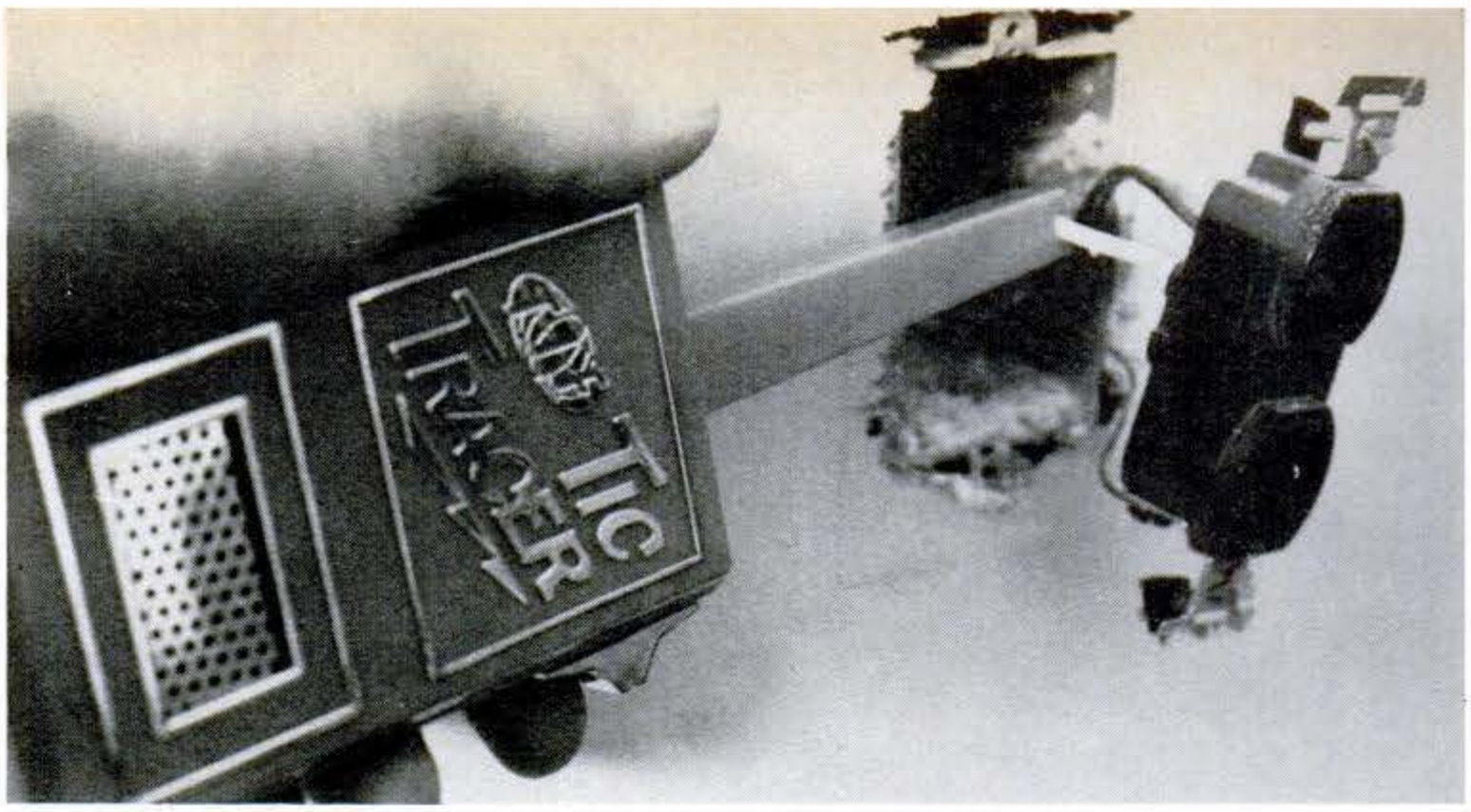


Pour a can in the gas tank. FUEL MIX breaks down the compounds that cement carbon particles to pistons, valves, cylinder heads. The carbon deposits loosen, flake off and are blasted out the pipes. Quickly, surely.

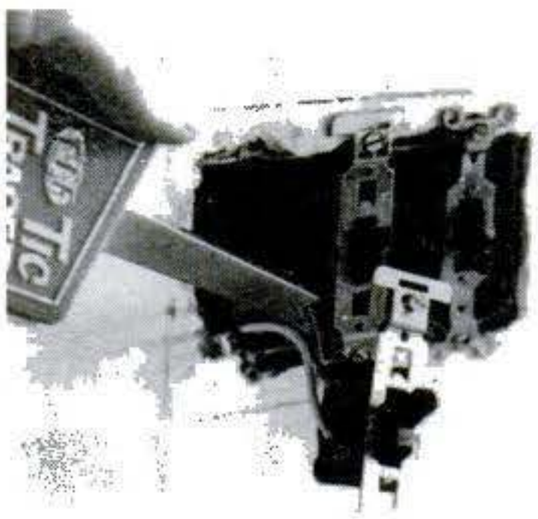
FUEL MIX also eliminates "dieseling" or "after run" caused by red hot carbon particles. It's great for new engine break-in and after valve and ring jobs, too. Puts needed lubrication in the hot upper cylinder areas, protects cylinders from scuffing and scoring. It really works! It's from the makers of...

GUMOUT

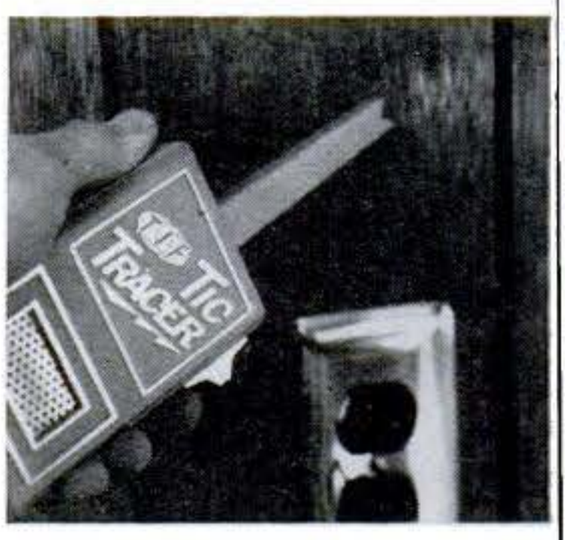
Pennsylvania Refining Company, Cleveland, Ohio 44104
Also available in Canada



Place Tic Tracer near a hot wire and it ticks. There's no electrical connection.



Following the path of hot line inside a wall (right) can be impossible. Tic Tracer makes it easy. It can detect a field two to three inches from its probe. Situations as at left, where hot and neutral wires run closely together, can sometimes confuse tracer.



TIC TRACER — Tells You Which Wires Are Live

The fastest way to find a hot wire in a maze of others is to touch it. A safer—if slower—way is to use a volt meter or an indicator lamp. Now there's a third tool, faster than a meter and less painful than a finger.

It's called Tic Tracer and that's exactly what it does—ticks as it traces an AC electrical field. The stronger the field, the faster the ticking. But what sets it apart from conventional testers is that the Tic Tracer does not physically connect to the circuit. It simply has to be close to it.

Not sure whether a wire is hot or neutral? Just place it in the forked snout of the Tic Tracer. The slow, repetitious, once-a-second beat suddenly erupts into a raspy clamor if the wire is passing an AC voltage (DC has no effect).

The works. Inside the probe of the Tic Tracer is a small coil that senses the voltage through induction. The small voltage induced in the coil from an outside AC field is used to change the rate of a low-frequency, free-running oscillator inside the plastic body. The output of the oscillator is then amplified and played through a small speaker. The result: ticks. Two AA batteries supply the necessary power to the oscillator and the amplifier circuitry.

Sensitivity? You can check everything from low-voltage thermostat circuits right on up to industrial supply stations. In fact, the tester is so sensitive, I found that it sometimes led me astray.

In testing a multiple light switch receptacle, for example, I found the close proximity of hot wires to the wire I was trying to test gave a false indication. In some cases, I heard a slight deviation from what a voltage carrier should sound like, indicating that the true source was farther away from the tip of the probe; but in other cases the difference was negligible.

It's a wire tracer, too. That's one use that its maker, TIF Instruments (3661 NW 74th Street, Miami, Fla. 33147), hasn't thought of. The Tic Tracer is sensitive enough to pick up your house wiring right through the wall. (Plastic jacketed wires only; not BX or conduit-shrouded wires.) If you've ever tried to figure out where a line comes from or where it's going inside an enclosed wall, you know what an asset this clever, but simple, gadget can be.

If you do a lot of house wiring or industrial wiring, a Tic Tracer can save you time and irritation. The average homeowner, however, with just a socket or switch to check occasionally may want to think twice. For $24.95 you can buy quite a few neon testers.
—*W. J. Hawkins*

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SAFER. Leave the tractor seat and a safety switch shuts off power to the motor and instantly stops the mower blades. A rear discharge mower puts clippings and debris under the tractor. Power lift or quick lever action easily raises or lowers the mower, snowthrower or dozer blade. Without leaving your seat. And you choose between front or under-mounted mower.

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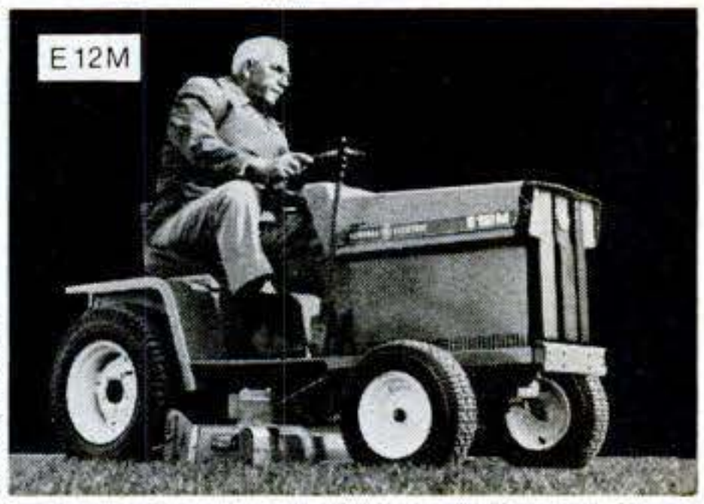
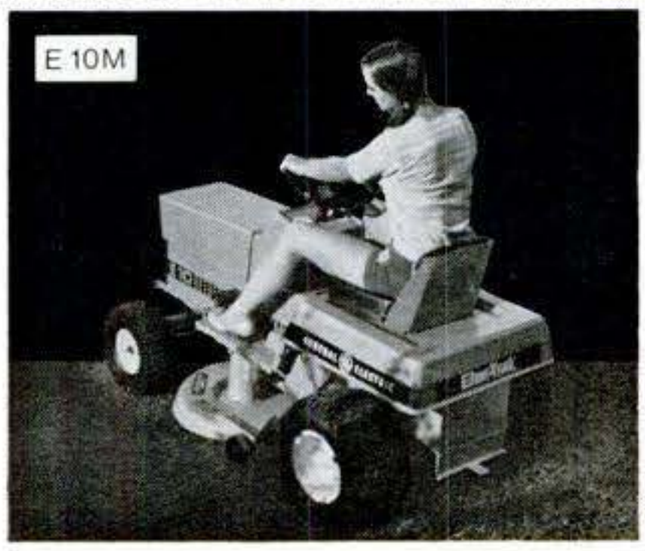
*Manufacturer's suggested retail price for E8M plus taxes, dealer setup and freight charges.





GENERAL ELECTRIC

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Recreation Roundup

. . . on the go with PS

By HERBERT SHULDINER

Another small idea for campers with compact cars

The Playpac is a new mini-trailer that's designed for towing by subcompacts like the VW above. Even though it's tiny, the camper can sleep six and has a toilet and full galley. It is 13 feet three inches long and seven feet four inches high. Width is seven feet and interior headroom is an inch over six feet. Playpac Industries, Inc., 1855 Hyland Blvd., Staten Island, N.Y. 10305, tags it at $1,795.

Remember the Combi-Camp 500 shown some time ago [Recreation Roundup, Nov. '71]—a 420-pound Danish camper that opens like a clamshell to create a commodious outdoor shelter? It's now being distributed in the U.S. by Nemet International, 153-03 Hillside Ave., Jamaica, N.Y.; Combi-Camp Midwest Inc., 13840 W. Warren Ave., Dearborn, Mich.; and Hanson Bros., 1500 Hiway 99 N., Eugene, Ore. 97402.

Camping becomes a numbers game

Early last March, an official of the Long Island State Park Commission in New York dipped into 1,520 applicant numbers and started drawing for 165 available campsites at Hither Hills park. About 1,100 applicants wound up with permits to use sites during July and August. Some 30 percent were frustrated in their wish to camp at the beautiful but over-popular park this summer.

Disappointment may be in store for many other campers, as the number desiring to use our limited recreational areas skyrockets. In "Can the National Parks Meet Your Changing Needs" [PS, May], George B. Hartzog Jr., director of the National Park Service, hinted that plans were in the works to curtail visitors to overcrowded national parks.

In late winter, Secretary of the Interior Morton announced plans to cut down on overcrowding in wilderness areas. This will affect Great Smoky Mountain, Rocky Mountain, and Sequoia-Kings Canyon National Parks, which suffer the greatest overuse problems. As many as 200 people have crowded into a trail shelter at Great Smoky originally designed to hold a dozen people, a Park Service spokesman tells us.

How this will work is still up in the air as we go to press. Despite Morton's directive, the park superintendents, who have great autonomy, have been slow in formulating plans to curtail wilderness crowding. There's a good chance that permit quotas in some national parks won't be fixed until summer.

Still, if you're planning to visit any of these parks this season, it would be a good idea to write or call for information on permits. Otherwise you might find you travel a long distance for naught.

Secy. Morton says that entry into back-country areas of the three parks will be restricted by instituting a permit system and limiting the permits issued "to the number of campers, horseback riders, and hikers that the fragile environment of areas can accommodate without damage."

Learn boating in your living room

The National Safety Council tells us there is now a learner's kit for mastering inboard, outboard, and I/O boating skills. The do-it-yourself kit was developed by the Evergreen Safety Council, 822 John St., Seattle, Wash. It's available from them for $4.95.

Quietest snowmobiles arrive

Recently I witnessed a demonstration of a new super-quiet Outboard Marine Corp. snowmobile in Milwaukee, Wis. Its noise emission measures no more than 73 decibels on the A scale at a distance of 50 feet—some 85 percent quieter than most 1973 snowmobiles. The Evinrude TW-30-Q (shown above) and the Johnson Golden Ghost will both have this quiet package and will be produced in limited quantities in time for the '73 season.

Warranty innovation for campers

Coachmen Industries recently launched a "full-coverage" warranty program covering its trailers, pickup campers, and motorhomes for everything except tires, batteries, and motorhome chassis. This one-stop warranty should be a great convenience to the RV owner who usually has to go to each appliance manufacturer for warranty service. Now he can go to the same dealer for all appliances. An idea that should spread.

First aid for disabled RVs

Dodge recently sent out a whole fleet of emergency-service vans, like the one below, right, to give free "first aid" to disabled recreational vehicles. The vans will tour campgrounds and national and state parks around the country. They'll also help any marooned RVs they spot along the roads they travel. "The emergency van service is designed to get the vehicle to a nearby RV service center or to any other competent mechanic for permanent repairs," says Robert H. Kline, Dodge service director. PS

New federal RV rules coming

President Nixon has ordered the Agriculture, Defense, and Interior Departments, and the Tennessee Valley Authority to issue regulations covering off-road vehicle use on their lands by early next month. This means they must create trails for snowmobiles, minibikes, motorcycles, trail bikes, dune buggies, and all-terrain vehicles, and ban the vehicles from areas where they might damage soil, vegetation, or wildlife. Surprisingly, most states have no laws covering off-road vehicles—except snowmobiles. Looks like the federal government is leading the way to full enjoyment of off-road vehicles without harm to the environment.

Mushrooming bikeways

The federal government recently gave almost $800,000 toward the development of two scenic bikeways along the southern California coast. A 19-mile trail will be built from Santa Monica to Torrance and a 3.1-mile trail will stretch along San Diego's bay. And Ohio has seven new bike routes designed to take you through some of the most scenic areas in the state. These tours run from 15 to 87 miles—the average length is about 30. All are marked with standard bikeway signs. You can get a free booklet "Ohio is Happening Along Bikeways" from the Ohio Dept. of Development, Box 1011, Columbus, Ohio 43216. It describes the trails.

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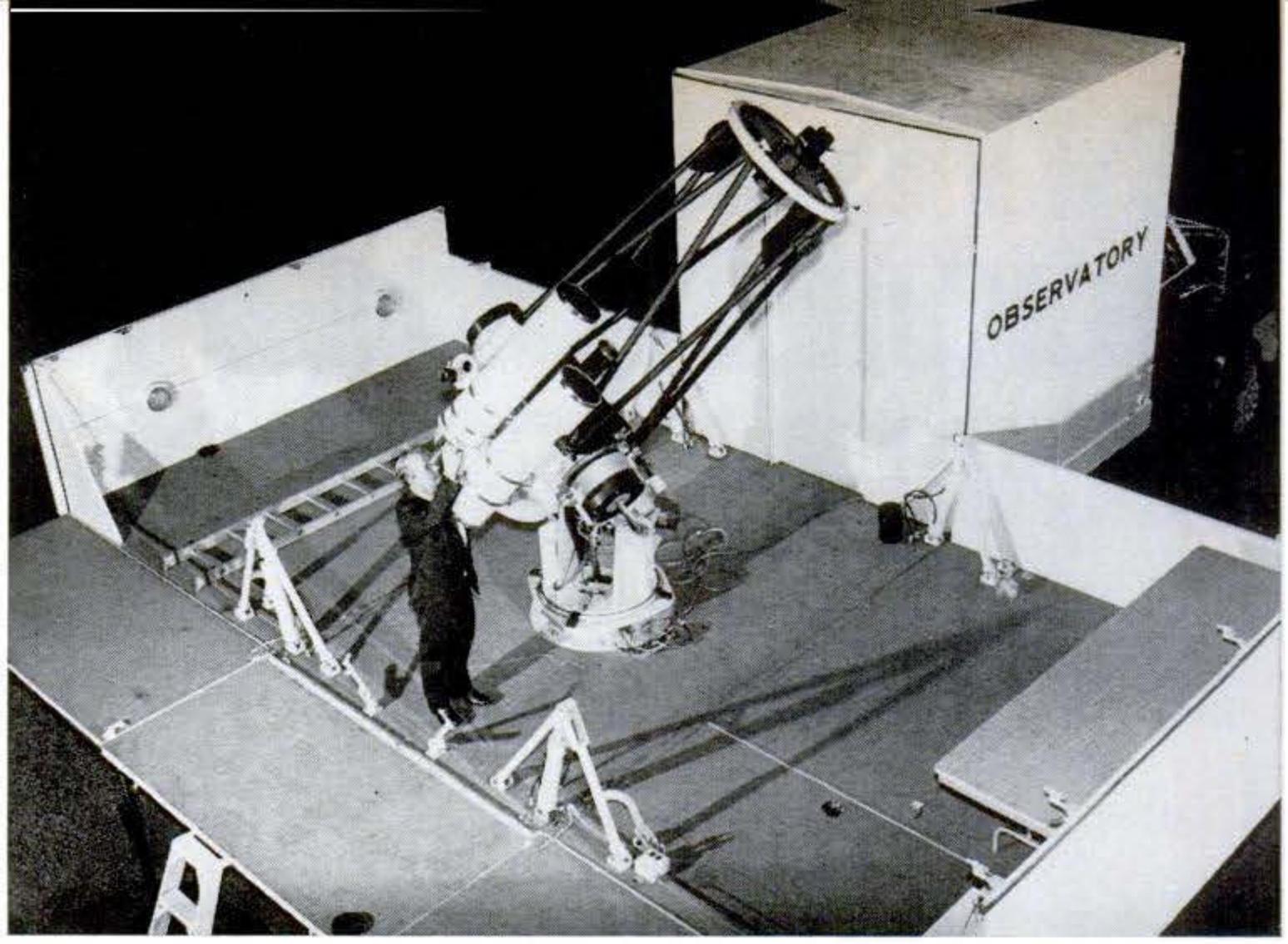
Science Newsfront

Last-minute news and notes to keep you up-to-date

By ARTHUR FISHER



Telescope on wheels probes high-altitude ozone layer

This mobile observatory, a 24-inch-diameter telescope mounted on a truck with a platform that unfolds, was built by Goodyear Aerospace for a NASA project—studying the 20-50-mile-high ozone layer that shields Earth from lethal ultraviolet radiation. Scientists can analyze the layer by seeing how it modifies light bounced back through it from a satellite—the 100-foot, balloon-type Pageos.

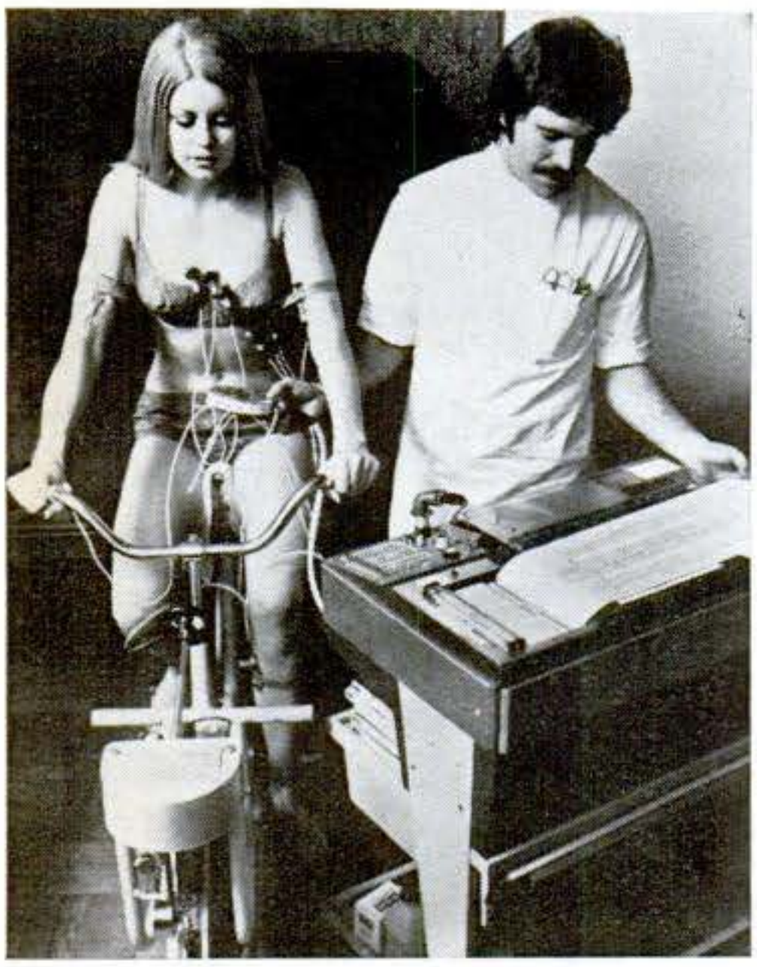
Animal comebacks

Five animal species that seemed on the verge of extinction not too long ago have made dramatic comebacks and may be out of danger, according to Dr. Carl L. Hubbs, a marine biologist with the Scripps Institution of Oceanography. The animals, which include some of the most fascinating mammals on Earth, are the gray whale, sea otter, northern elephant seal, and two species of fur seal.

According to Dr. Hubbs, credit for the preservation of the elephant seals, gray whales, and Guadalupe fur seals (all found chiefly in Mexican waters) belongs to the Mexican government. He told the annual meeting of the U.S. National Wildlife Federation: "I'm sure that if the government hadn't taken steps to protect these species, the dog- and cat-food industry would have been down there canning everything in sight."

Her heart belongs to Compu-Gram

Riding an exercise bicycle and wired to a unique, computerized electrocardio-



graph, this girl is participating in a new test to determine how age affects the heart's response to physical stress.

At the Orentreich Foundation for the Advancement of Science in New York City, hundreds of volunteers from 18 to 80 will have their electrocardiograms (EKGs) taken before pedaling the bike at predetermined speeds, loads, and times, then again immediately after pedaling and at one-minute intervals for seven minutes. The computer-EKG system, known as Compu-Gram, automatically records and analyzes several thousand measurements for each subject, providing physicians with an unparalleledly detailed diagnosis.

A print-out of the complete measurements and the diagnosis is presented within two minutes after the test. The foundation researchers and the makers of the equipment, Cro-Med Bionics Corp., hope the results will provide accurate information on the relation of the physiological age of the heart to its chronological age, potentially giving physicians the ability to forewarn of heart attacks.

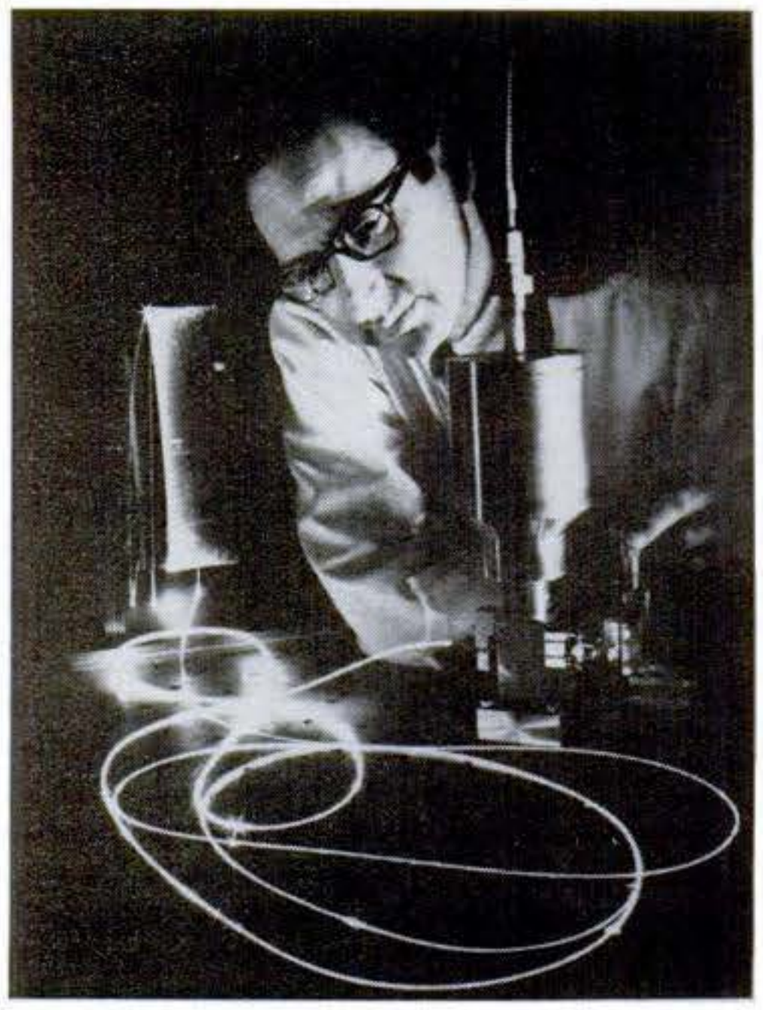
Clock paradox checks out

Why would two apparently sane scientists carry four atomic clocks aboard a plane, fly around the world with them, and then do exactly the same thing, only in the opposite direction? Simple. Physicist Joseph C. Hafele of Washington U. in St. Louis and Richard Keating of the U.S. Naval Observatory were trying to test the famous clock paradox, an Alice-in-Wonderland proposition stated by Albert Einstein in his Special Theory of Relativity. Briefly, it says that the actual passage of time depends on relative velocity—that time passes more slowly, for example, for an observer in motion than for one at rest. The effect would become really noticeable, however, only at extremely high velocities—close to the speed of light. Thus a star-trekker making a long trip outside the solar system might return to Earth *younger* than a twin brother who had stayed behind.

But the two scientists figured that the effect could be checked even at conventional speeds by flying ultraprecise clocks around the world both eastbound and westbound. Because of the Earth's rotation, there would be a marked difference in the Einsteinian effect on the two clocks; by theory, the eastbound clocks should "lose" 40 billionths of a second compared to an Earthbound reference clock, and the westbound clocks should "gain" 275 billionths of a second.

Results of the expedition (made last October, with calculations completed recently): Accurate to within five percent eastbound and 30 percent westbound of the predicted values. In Hafele's words: "The experiment was successful beyond our best expectations."

Leading light



Julian Stone, a scientist at Bell Labs, is shown here with a new kind of optical

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Filter Kings, 17 mg. "tar," 1.2 mg. nicotine; Longs, 18 mg. "tar," 1.3 mg. nicotine, av. per cigarette, FTC Report Aug. '71

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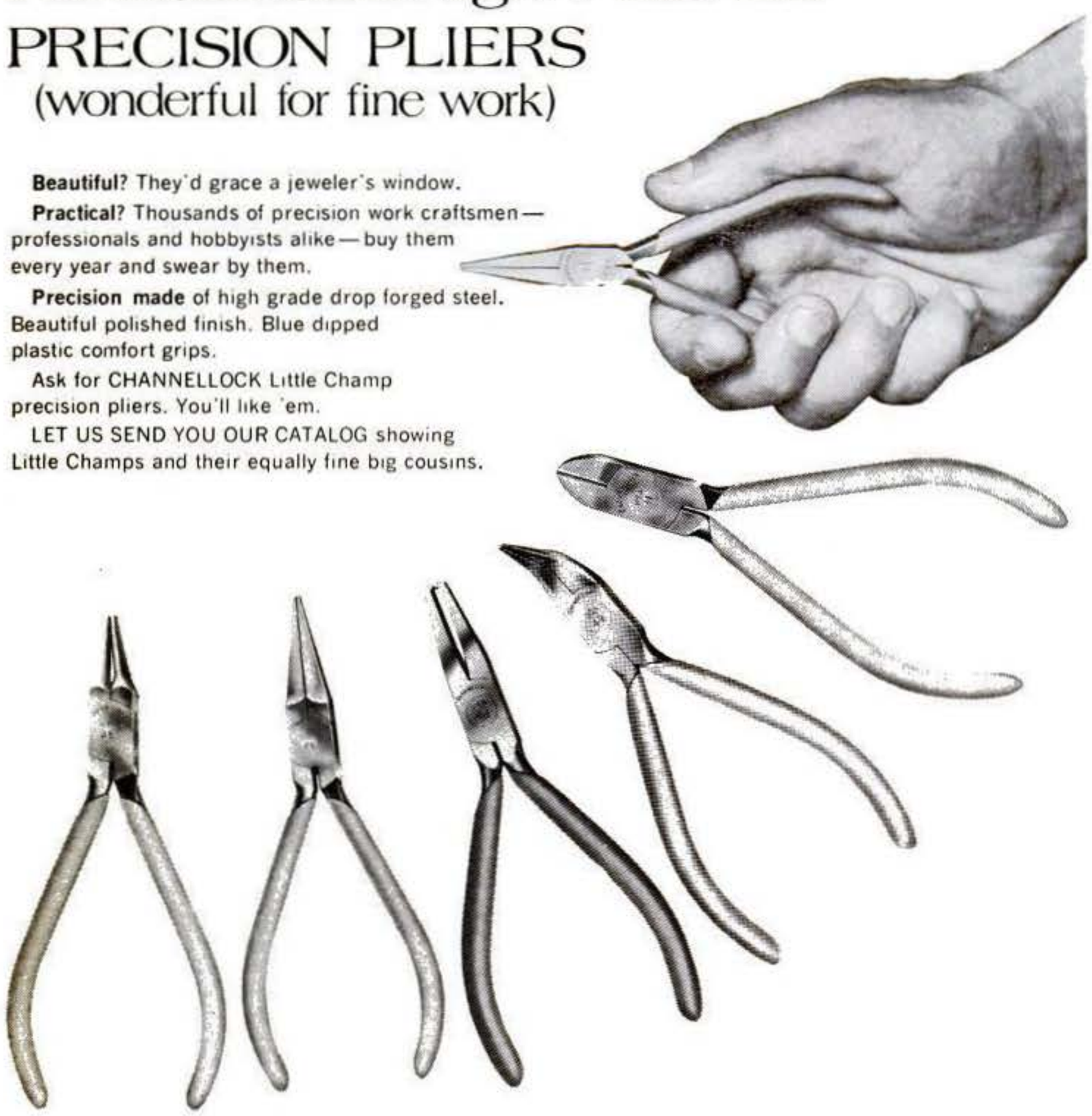

TOOLS BY CHANNELLOCK®
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Science Newsfront

[*Continued*]

fiber he developed. The fiber can be seen conducting light from a source at one end through a tangle of loops and on through coils of the fiber wound tightly on a drum. The news about this fiber is that it has very low loss, and that it is liquid-filled instead of solid. It consists of a fused-quartz capillary tube a mere 90 microns thick, filled with liquid tetrachloroethylene.

Communications systems in the future, when the volume of messages will rise to unheard-of volume, may rely in part on optical techniques. Telephone, TV, and other signals can be carried on modulated optical carriers in the visible and infrared parts of the light spectrum. Optical fibers for such systems offer the advantages of small size, low price, and large-bandwidth capacity.

Electronic can tester

This may come as one of life's great revelations: Did you know that cans and jars containing foods and beverages have up to now been tested for leaks or spoilage by tapping them? A skilled inspector (doubtless wearing some badge of office) would hit the top of a can with a drumstick and compare the pitch of the noise with that of a normal can. (Pitch varies with internal pressure, which will be abnormal if the vacuum seal has been broken or if bacterial action is generating gas.) Now there is a new way to perform the procedure, with a device called the Portable Electronic Can Tapper, or PECT for short.

Made by Benthos, Inc., of North Falmouth, Mass., PECT sends magnetic pulses through metal cans and the lids of jars, producing pings of sound that an operator picks up through a stethoscope. A bad sample pongs instead of pinging. And the test can even be made without removing the cans from their cartons.

Gasoline from shale oil

The U.S. Bureau of Mines has revealed that a "good quality" gasoline—lead-free and with an octane number of 89—has been produced from crude shale oil. Lawrence K. Barker, an engineer with the Bureau, said that the octane number and low nitrogen/sulfur content of the product compare favorably with regular gasolines. PS

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Detroit Report...

By **JIM DUNNE** / *PS Detroit Editor*

Chrysler Corp. goes to war on noise

Chrysler will make sure that none of its '73 cars produces over 84 db of noise at wide-open throttle. To meet the goal, the company has changed intake and exhaust systems. The cars will be quieter inside, too. Better seals along the beltline will cut much of the noise entering through window joints. In the Imperial, foam seals under the windshield and backlite will hush wind noise, and a mastic pad will cover the entire floor area. A "super quiet" Charger will be offered in the intermediate line, with sound-proofing similar to the Imperial's.

Better brakes at no extra cost

Chrysler will make front disk brakes standard equipment on all its 1973 models except six-cylinder Darts and Valiants. Power disks are standard on all full-size cars, wagons, and virtually all V8-engine cars. Unassisted disks are standard on all the others.

The company is introducing a new third-generation slider-type brake that uses a single-piston caliper instead of the four-piston fixed-caliper type now used. The new design is simpler and improves performance. It is also less expensive to maintain. Cars equipped with the new brake have a half-inch-wider track. Also, disk-brake linings will be slotted to improve stopping performance. On drum-brake cars, performance is improved by the use of a $\frac{1}{16}$-inch-larger-diameter wheel cylinder in the front.

Putting driveability back in engines

Engines in the 1973 Chrysler cars will have a number of innovations aimed at improving operation. All Chrysler Corp. cars built in the U.S. will get the electronic-ignition system that has been gradually introduced on Chrysler V8s over the past year. A new higher-speed starting motor will be used on 360 V8 and larger-displacement engines. The starter cranks about a third faster than present Chrysler starter motors. Eventually, when supply catches up with demand, this higher-speed unit will be put on all of the company's engines.

Also, a spool-type engine mount will be used on all Dart, Charger, Valiant, and Satellite models. This mount limits forward/rearward engine motion much more precisely than the sandwich mounts now used —critical in protecting the radiator in five-mph frontal crashes.

New bumpers are way out in front

Styling of the 1973 Lincoln-Mercury line will feature new sheet metal for the Monterey and Marquis and new bumpers for all cars. On the Marquis, the traditional Mercury grille and hidden headlights are carried over with minor changes. Skirts over the rear-wheel openings give the car a smoother, more finished look. The heavy front bumper—designed to meet the new five-mph-impact standard—sticks out about three inches from the grille. If the Mercurys are typical of next year's cars, the new bumpers will not be blended in with the sheet metal, but will present a more functional look—especially on the larger, heavier cars where collision forces are greater and require much more protection. On most of the models, parking lights have been removed from the bumpers and placed in a protected position in the leading edge of the fenders. Vertical, rubber-faced bumper guards are used on almost all cars in the L-M line.

Building a better spritzer

A new type windshield washer will be used in the 1973 big Ford models to wet down more of the glass surface. Washer jets will be located right in the wiper blade. As the wiper swings back and forth, cleaning fluid will be sprayed on a wide arc of the windshield. This system has been suggested many times in the past, but engineers always were stumped by the flexible coupling that was needed to swing back and forth with the blade. Now it appears that the problem of keeping a tube flexible in all temperatures has been licked.

Ford will also offer for the first time a remote-controlled right outside mirror that can be adjusted for position from the driver's seat. Few of these controls are seen on present cars, even though the problem of adjusting the right side mirror is much more serious than that of the driver's side. Ford will make this system an option on the 1973 LTDs.

GM Rotary engine assigned to Chevy?

GM's Wankel-engine project is entering a new stage of development. GM is expected to appoint one of the car divisions to take over direction of the complete GMRE program —including manufacturing, styling, marketing strategy, and production. This moves the GMRE out of the development laboratories and into the mainstream of GM's traditional product-introduction schedule.

Chevrolet is expected to get the nod. Chevy has the enormous manpower, experience, and facilities needed to introduce the radical new motor.

Electronic radio horns on the way

Pontiac has developed what it calls a "horn of the future" that sends its warning signal over radio waves. The electronic warning device is actually a miniature transmitter/receiver that works by pressing the horn button on the steering wheel. A buzzer or similar warning signal sounds in the car ahead, operating through the radio speaker. In addition, the traditional warning horn will sound outside the car to alert pedestrians. Locomotive engineers, police, and firemen can use the new system to warn all traffic in their paths. Range for the unit would be kept to approximately 600 feet, using low-frequency Citizens Band radio. Need for a radio horn becomes more evident as cars are made to exclude more external noise and air-conditioning units spread the incidence of closed-car driving.

Rotary-engine research at Ford

Ford's progress with development of the Wankel engine has been slow. Two factions within the company are battling over the merits of building a rotary engine, and so far the anti-Wankel group, made up of executives from the engine and foundry section, is winning out.

This is a replay of the aluminum-engine controversy that gripped Ford almost 10 years ago. At that time Ford's competitors were in favor of aluminum engines, but the E&F group said no, Ford should stick with iron engine blocks. Events proved that the E&F group was mostly right on the aluminum-engine question, and the same executives are now saying they are right again in opposing the Wankel. Meanwhile, Ford's competitors, both in the U.S. and overseas, are going ahead full steam on Wankel projects, leaving the Dearborn company farther behind. Now Ford's top executives are wondering if E&F's advice could be wrong. PS

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Today, a man needs a good reason to walk a mile.

Start walking.

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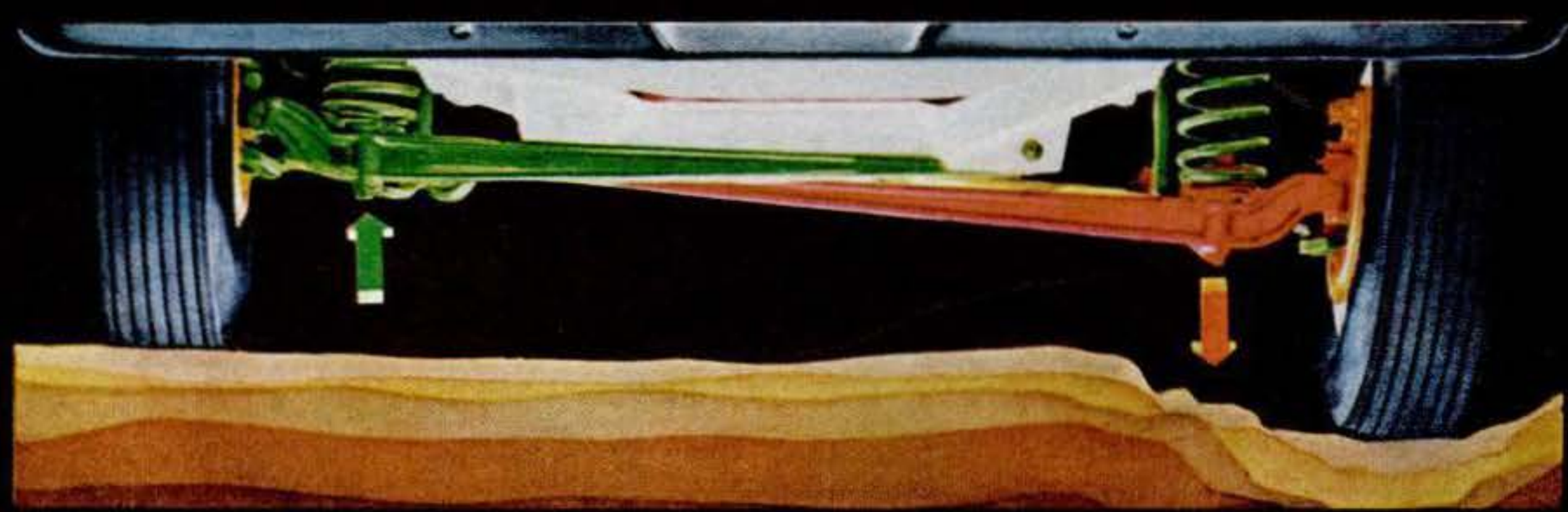
Works like a truck.

Ford pickups ride and handle like no other pickup. That's because no other pickup has Twin-I-Beam independent front suspension. Each front wheel has its own forged I-beam axle with a big coil spring that works independently to step over bumps, cushion the ride. Steering is firm, precise. Cornering is flat with little sidesway on curves. And there's practically no nosedive when braking. In the rear, a unique leaf-spring suspension is offered that automatically adjusts to loads, maintaining a smooth ride, loaded or light. And loads are what Fords seem to thrive on—92 out of every 100 Ford trucks sold in the past 12 years are still on the job. Pick up a fully detailed catalog at your Ford Dealer's. And while there, test-drive a new Ford. Check it for roominess, quietness, easy handling and all-around driving enjoyment. Then see if you can keep from driving it home.

Rides like a car.



A better idea for safety: Buckle up.

FORD PICKUPS

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PS: What's News...

Keeping You Posted from Behind the Scenes

The Experimental Safety Vehicle shown on our cover this month was first displayed to the public at the New York Automobile Show this spring. When our cover artist, Ted Lodigensky, was painting our cover illustration it had not yet been unveiled, so the only impression we had was from photographs and engineering drawings. To meet our deadline, we had to ship the art to the engraver on the day before the auto show opened. As I walked around the real car at the show, I gained a new appreciation of the magnificent job Ted had done of capturing the image of the car in oils—and I was a little bit sorry I had decided that our cover should show half the body cut away to reveal engineering details. The most impressive contribution this car makes to safe-car technology is to demonstrate that a safety car need not look like an army tank. Though appearance has little to do with safety performance, it has a lot to do with getting people to buy a car, and the safest car in the world won't save any lives if no one buys it.

The boy who lost his arm—and got it back

We published a story in November 1962 about a 12-year-old boy in Somerville, Mass., who had his arm completely severed in a tragic accident, and about the doctors at Massachusetts General Hospital who made medical history by sewing the arm back on. A reader wrote me recently asking what had happened to the boy, Edward Knowles. We checked with Dr. Ronald Malt, one of the doctors who participated in the precedent-setting operation, and learned that Ed Knowles, now 22, is a partner in a company specializing in racing dragsters. His thing is auto mechanics. "He's got a good, strong arm—infinitely better than any artificial limb," says Dr. Malt.

Your most important tool

An offbeat article we published in the August 1970 issue has won an important award for the author. Dr. Jack Runninger, a Rome, Ga., optometrist, was named the winner of the American Optometric Association's 1971 Public Service Award. The theme of his award-winning article, "Making Glasses Fit Your Job": the most important tools in your shop are your eyes. For those who wear glasses, he described the wide variety of designs available and how to choose the ones best suited for the job at hand.

Once more about the Wankel

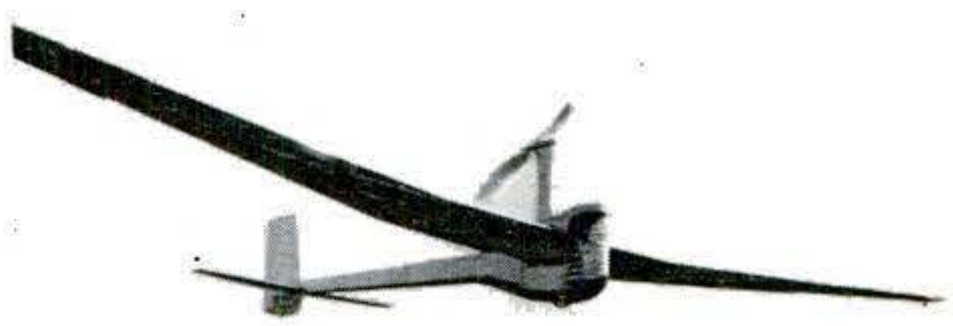
The tight security GM has maintained since it began an intensive development program on the Wankel engine 18 months ago has been eased—slightly. (The reports you have been reading in POPULAR SCIENCE are based on information from reliable but unofficial sources.) Tucked away inconspicuously in a 75-page booklet recently mailed to GM stockholders is the statement by GM officials that GM has made rotary engines with external-emission controls that have already produced emissions results as good as the best piston engines. Further details reveal that the ancillary equipment needed to clean up the Wankel emissions can be much simpler than that needed for piston engines. So far the Wankels they have tested yield about 25 percent poorer gas mileage than the best piston engines. But they say they are now making progress in the laboratory toward bringing the fuel economy up to the levels of piston engines. Measures taken to improve fuel mileage are, happily, also helping to reduce emission problems. The report goes on to describe, cautiously, the many other virtues of the Wankel —already familiar to readers of POPULAR SCIENCE.

Don't drown in your own ignorance

Although boating is statistically about the safest outdoor activity you could engage in this summer, favorable odds don't help much if you are among the few on the casualty list. Boating-accident records show that most of them are caused by the ignorance of the person in charge of the boat. To save your life and enhance your boating pleasure, the U.S. Coast Guard Auxiliary is offering a new 12-lesson boating course. The course is free. Check with your nearest Coast Guard unit to find nearby locations and starting dates.

Longest man-powered flight

The muscle-powered aircraft Jupiter, pedaled by Flight Lt. John Potter, flew some 500 yards in



one flight recently at a Royal Air Force Base in Oxfordshire, England. Wingspan of the plane is 28.8 feet, weight 140 pounds. Paul Wahl, who wrote our recent stories about man-powered flight [PS, Jan. '71 and Mar. '72], tells me that Potter has made 25 flights in Jupiter. He has flown as high as 25 feet. His airspeed was in the 22-to-25-mph range. He flew 400 feet in zero wind for the longest measured distance over the ground yet achieved by a man-powered aircraft. His takeoff run for this flight was 1,000 feet. His last flight was in a five-to-eight-mph wind; the plane drifted into a circular flight that hard-over aileron control could not correct. The aircraft crashed after traveling some 500 yards. The ground wheel buckled and the force of impact stretched the pylon supporting the prop. Potter was not hurt, and damage to the plane was not severe. He expects to repair the plane and fly it again soon.

Hubert P. Luckett

Editor-in-Chief

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Fairchild ESV has Plymouth running gear, a reinforced Fury body, and a front-end bumper that will extend and retract automatically.

The New ESVs: Race to Build

Spurred by federal contracts for Experimental Safety Vehicles, the auto industry and two non-automotive companies are developing cars to let you walk away from "fatal" crashes

By **JAN P. NORBYE** / *PS Automotive Editor*
and **JIM DUNNE** / *PS Detroit Editor*

Take a brand new $250,000 automobile. Load it with dummy passengers. Then drive it into a wall at 50 mph. The same with a second car. A few more—11 in all—ram into the wall so there's nothing left but a tangle of very high-priced metal and plastic—and one thing more: a basis for the know-how that will let you walk away from a "fatal" crash. That's the goal GM set in creating a fleet of ESVs to specifications laid down by the Department of Transportation.

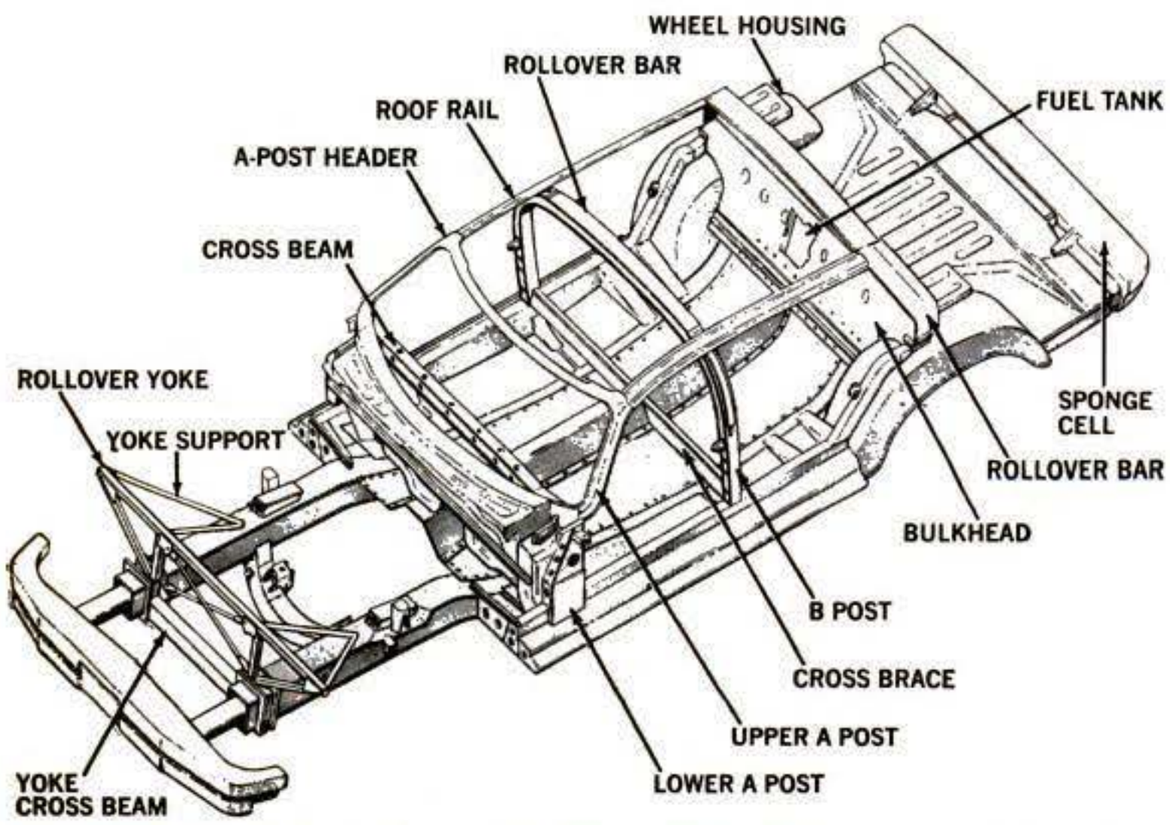
Ford has a similar program, but started later. Two companies in other industries also have ESV programs: AMF, Inc. (formerly American Machine & Foundry Co.), and Republic Division of Fairchild Industries.

Purely research vehicles. Neither the ESV builders nor DoT looks on these cars as protypes for production. They are being built because we don't know enough about car safety. We lack the technology to make passive-restraint systems that will assure survival in a 50-mph crash. We lack crash studies to tell us what happens in different kinds of impact. Industry and government want the answers—answers that will determine future safety standards.

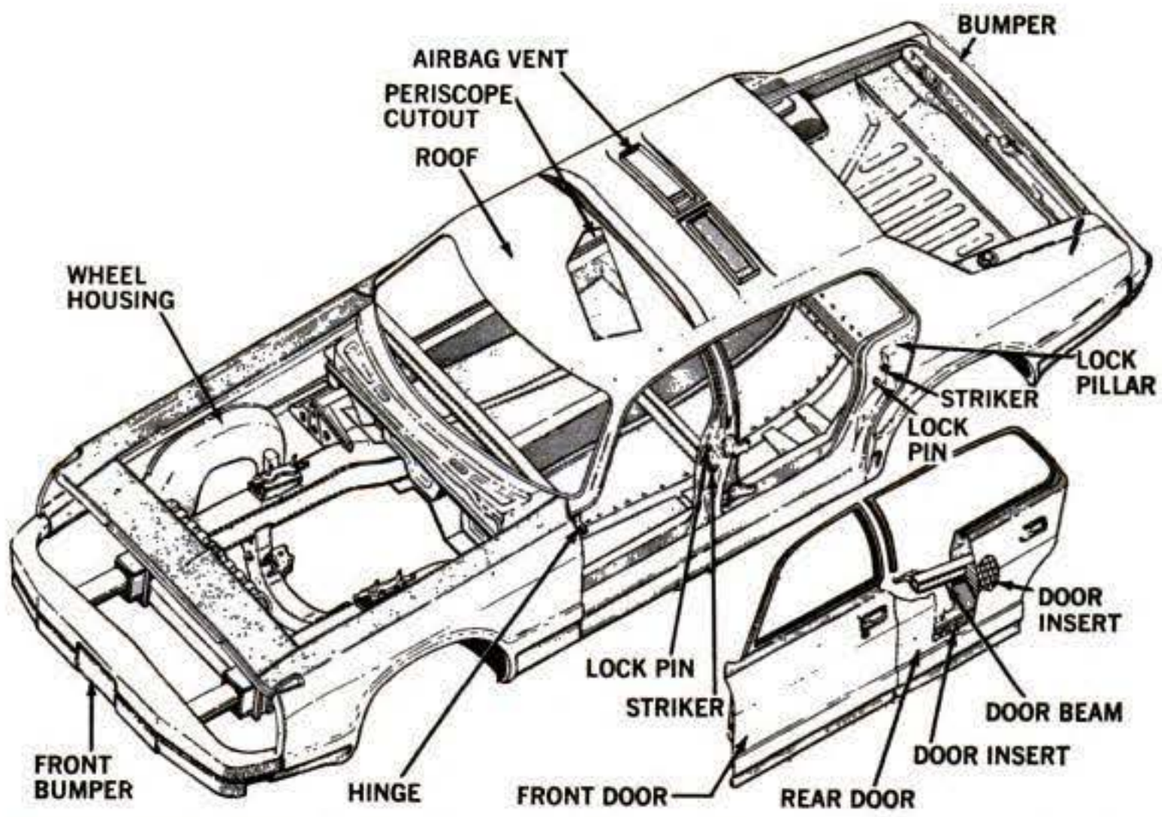
The performance-capability requirements for the ESVs must not be read as a proposal for future standards. They are merely goals devised with the aim of establishing limits of feasibility. Requirements fall into two categories: passenger protection and performance. In the first category, the car must:

- Keep passengers alive in a 50-mph crash into a solid barrier, at angles up to 15 degrees to left or right from head-on.
- Withstand side impacts at 30 mph, rear-end collisions at 75 mph, and two complete rollovers at 60-70 mph.

Can it be done? In GM's first test, the dummies were killed, but "only



Fairchild ESV unit body with front stub frame provides extra structural stiffness with rollover bars, cross bracing, and a full-width bulkhead installed aft of the back seat.



Doors and door locks are heavily reinforced for side impact resistance. Roof structure has cutout for periscope mirror mounting and vents to relieve interior pressure on airbag deployment.

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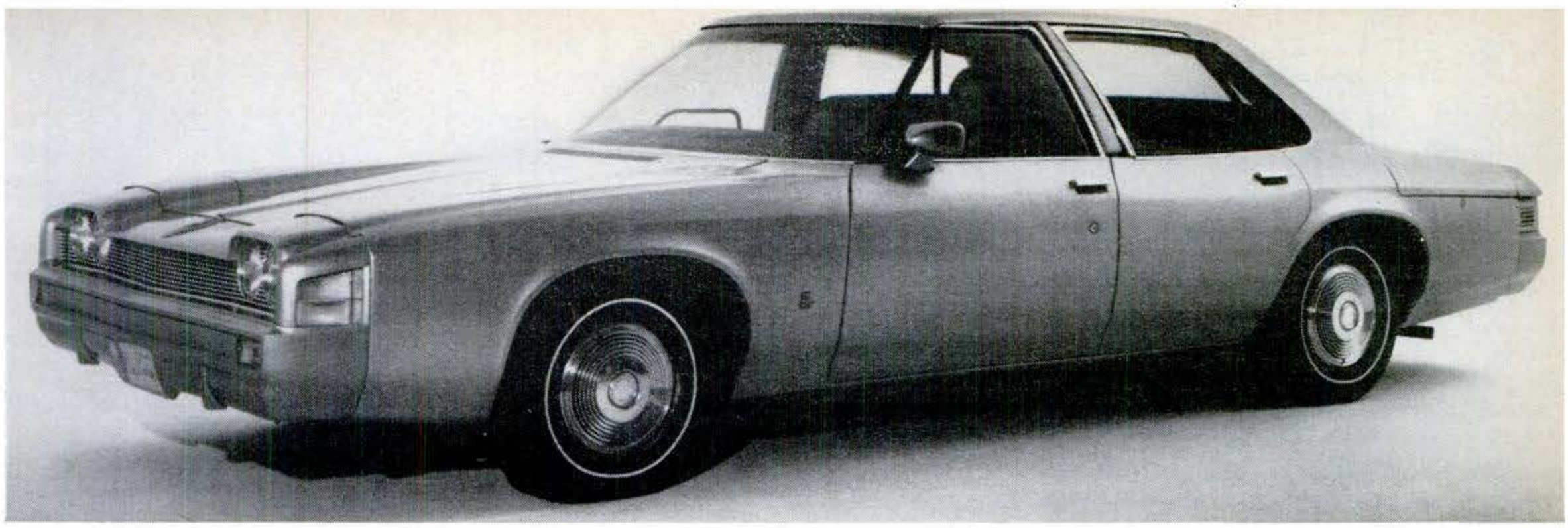

General Motors ESV has all-new body and chassis components, modified Oldsmobile V8 power package, many aluminum body panels.

the World's Safest Car

slightly killed." What that means is that the test was close to successful even though it failed. Perhaps the dummies would have survived the crash at 47 or 48 mph. That indicates that DoT goals are not beyond the reach of present technology.

Further tests will get underway soon: DoT will crash-test the cars when they are delivered. The actual testing will be done under contract by the Dynamic Science Division of Marshall Industries in Phoenix, Ariz. The AMF, Fairchild, and GM ESVs are expected to go on test in December.

Passive safety is not enough. An ESV must meet tough performance standards, too:

- Stop from 60 mph within 155 feet on a dry surface. Wet-stop-ability goals are set so that four-wheel anti-locking brakes are indicated.
- Maintain 0.6-g lateral acceleration on a 100-foot-radius circle, and make an abrupt 180-degree J turn at 70-mph entry speed without rolling over. These maneuvers demonstrate a certain level of evasive ability.
- Accelerate from 30 to 70 mph with a 60-percent load in less than 12

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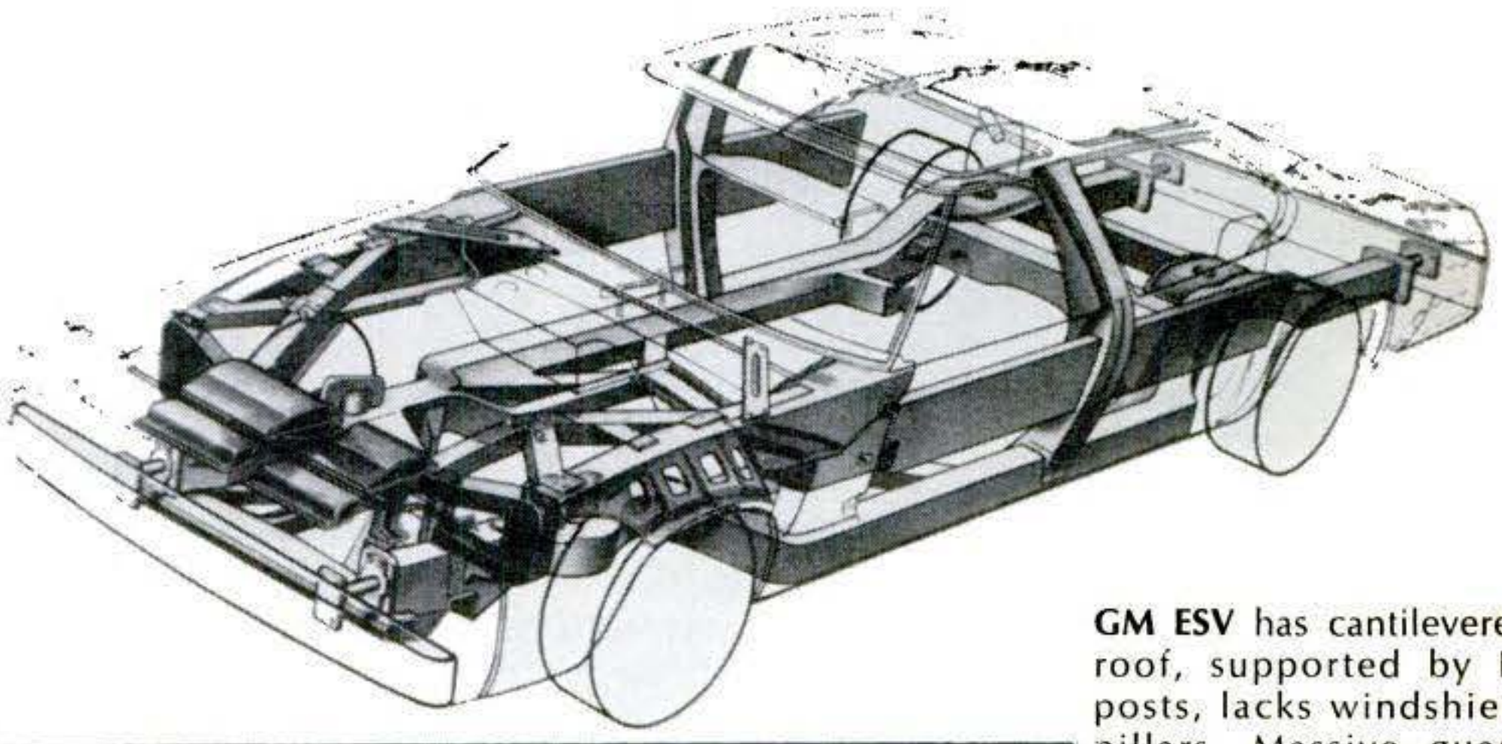
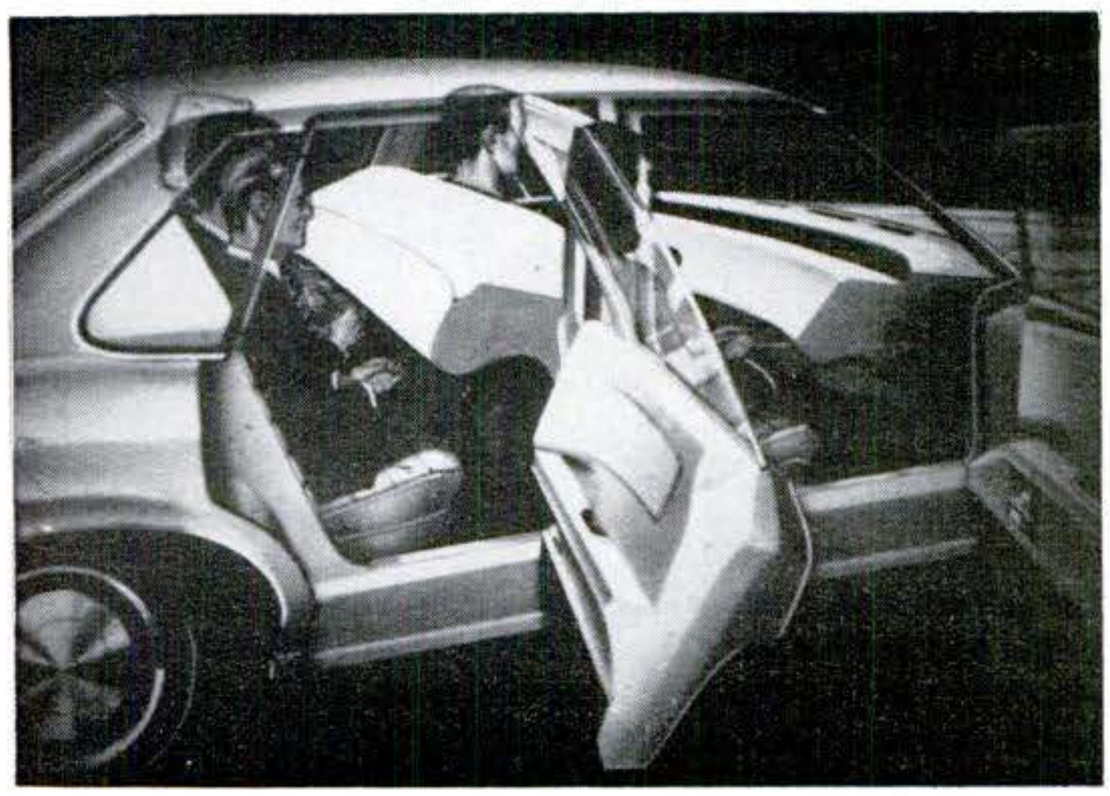


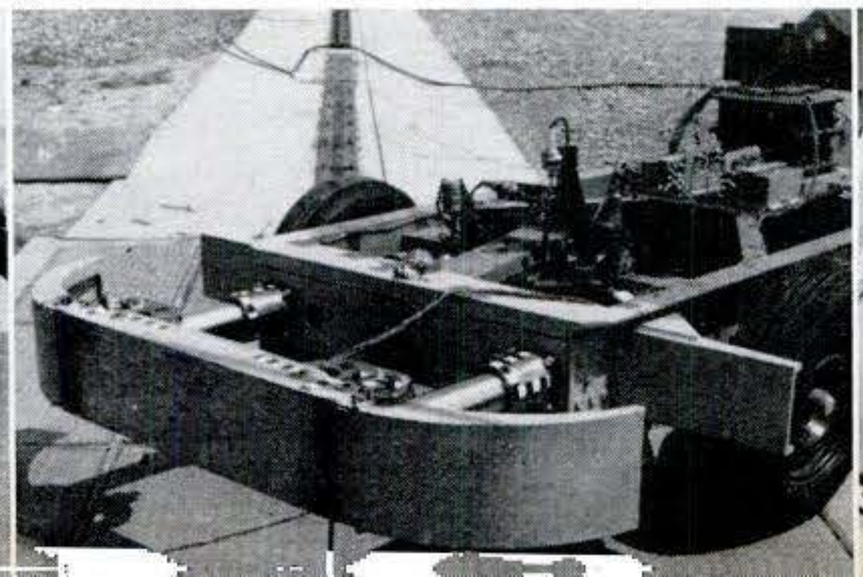


GM ESV has cantilevered roof, supported by B-posts, lacks windshield pillars. Massive guard beams run through doors, adding to perimeter frame rigidity. Front end is reinforced for bumper back-up and support, collapse in sections in severe frontal impact. Diagonal bracing is designed to absorb corner impacts.

Cross-car padded structure called a "credenza" protects rear-seat riders. Air bags won't deploy in impacts under 30 mph, as credenza is adequate up to that speed. Entry/exit is extremely difficult.

AMF's ESV has vault-strong steel body structure, with massive windshield posts. The enormous bumper is aluminum.

AMF bumper system is hydraulic, with 30-inch travel to absorb crash forces in a high-speed head-on collision.



Interior view of the AMF ESV shows air-bag installation in steering-wheel hub, high center console, and fixed seats.

European auto makers reject the idea of absolute survivability in high-

Volkswagen ESV will weigh in at about 2,600 pounds. Overall length will be under 180 inches. The car's bumper and body are designed to give 50-mph protection in a crash.

"Three-ply construction" is how Volkswagen describes the body of its ESV. There is an inner shell around the passenger compartment, an outer crumple zone, and then the bumpers.

Ernst Fiala, head of research at Volkswagen, talks with Douglas W. Toms (right), federal NHTSA administrator, and explains the collapse sequence of the ESV front end in a crash.

A number of passive-restraint systems are now under experimentation at VW. One novel one is an automatically deployed "blanket." But both belts and airbags are being tested, too.

seconds. DoT sees this as a basic requirement for safe passing and freeway entry.

None of the ESVs meet all the requirements. All are overweight. DoT called for 4,000 pounds maximum, with a 200-pound margin. They all come between 4,600 and 4,900 pounds. They may fail in other areas, too, but that's not breach of contract. Remember, it's a research program, and we're trying to find out exactly what is possible and what isn't.

A word of warning here: There are some who would like to set standards on production cars at or just beyond the limit of technology. But advocates of such legislation tend to overlook the economic realities.

Commonsensical standards. Future standards must be set with full awareness of what compliance will cost the consumer. If cars had to be built to ESV specifications, they might not all cost $250,000, but even at 10 percent of that, only the very rich could afford a car, and the auto industry would find itself without further use for its assembly lines. There's no plan for such action.

We stress this point to make sure that you see the ESV program in its proper light. It's an engineering exercise with a strong competitive element, with a good chance of producing new ideas or fresh applications of old ideas.

Douglas W. Toms, Administrator of the National Highway Traffic Safety Administration, said the ESVs represent an initial experiment to build in safety from the ground up rather than add safety devices on a piecemeal basis. In other words, a giant research program, representing, as Secretary of Transportation John A. Volpe phrased it, "a combination of engineering skills and talent aligned against the common foe of death and destruction on the highways."

Safety research isn't limited to the U.S. ESV project; it is a topic of worldwide interest. The ESV program has taken on an international flavor, as DoT has signed Memoranda of Understanding with Germany, Japan, Great Britain, Italy, and France. The last to join up was Sweden. Two international ESV conferences have been held, a third is going on now.

The imports. The weight target for European and Japanese ESVs is 2,000 pounds, and it's clear that nobody knows how to assure 50-mph crash survivability in such a light car. This is not because small cars are less safe, but because the bumper systems needed would add so much weight!

Higher weight means higher cost, and the same added weight that improves passive safety could cause a deterioration in active safety. For instance, heavy bumpers hanging way out in front and in back of the car could upset handling characteristics.

More power? Added weight means a larger engine, if performance levels are to be maintained. That means higher cost, lower gas mileage, more pollution, and fewer sales. Cars would be longer and probably wider, impeding the flow of traffic.

There's much truth in all these arguments, but the foreign engineers and executives who argue against the ESV program do so as if the requirements were proposals for standards, not a research program in which we can all help each other. The world may never want to place an ESV in production, but we sure want the answers the cars can give us.

More and more European and Jap-

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speed automotive crashes and, instead, promote "active" safety

The Mercedes-Benz ESV is basically a standard production car—a Type 250—with special bumpers and other modifications. The net seen in the rear window replaces head restraints.

anese companies are building ESV-type cars, with more or less uniform performance objectives. Germany was first to act. The VW and Mercedes ESVs are shown. Opel has a small car that contains many essential elements of the GM ESV.

In Italy, Fiat is working on two ESV concepts—a small 1,200-pound job based on the 850, and a compact 1,200-pound model based on the 124. Subsystems under development include most areas covered by DoT specifications, plus fire protection, safe driving in fog, and vehicle/pedestrian impact protection. Construction and testing is slated for 1973/74.

In France, Renault and Peugeot are collaborating on safety studies for a 2,000-pound ESV, while Citroën is concentrating on a smaller 1,400-1,600-pound model.

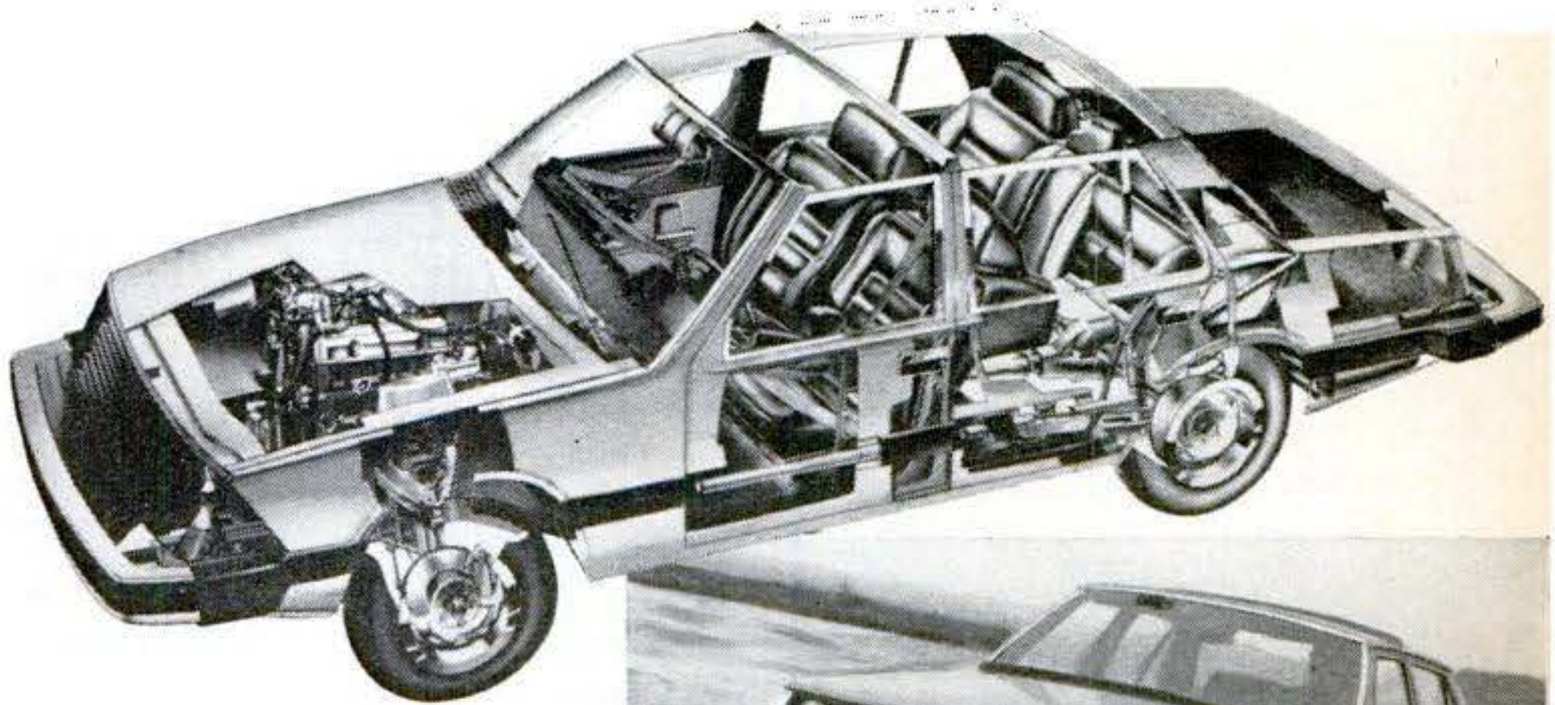
In Japan, three companies are active in the ESV program: Nissan (Datsun), Toyota, and Honda. The Nissan timetable calls for building 20 2,500-pound ESVs for late 1973.

The Toyota is planned as a 2,000-pound two-seater, while Honda is designing a 1,650-pound four-seater. It will be a minicar with an overall length under 140 inches, powered by a 55-hp engine. Construction is planned for late '74.

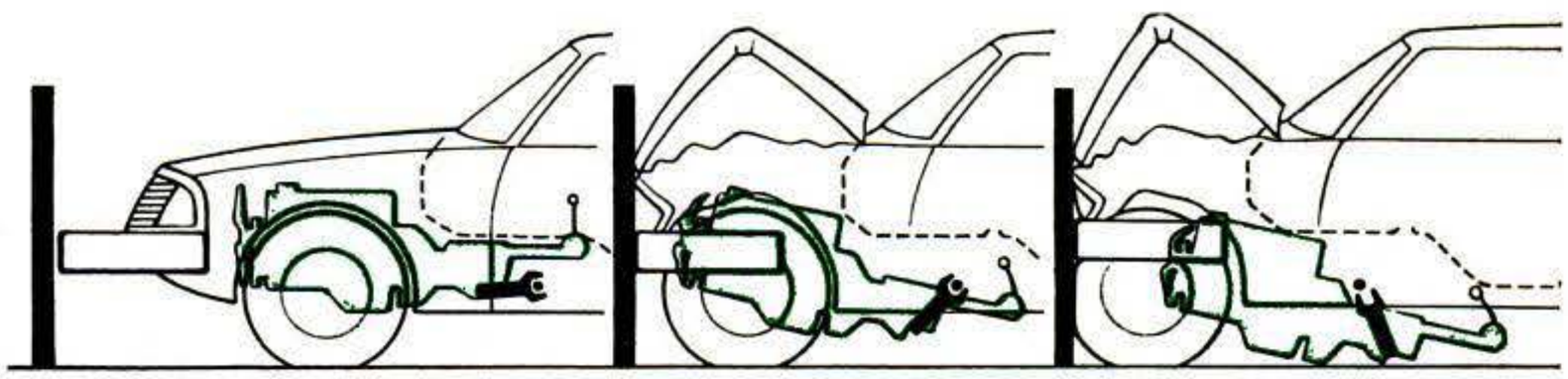
Swedish efficiency. Volvo has quietly built its own safety car without regard to DoT requirements, but will participate in the international ESV program in future. The Volvo ESV weighs 3,200 pounds and has a number of innovations (see drawings). Ten cars are under construction; preliminary tests will begin next month.

We expect future safety standards to be formulated in accordance with the findings of ESV tests, as is Doug Toms' intention. But we also expect that individual features from the ESV cars will begin to show up on production models long before there will be any legal requirements for them. PS

Key to the Mercedes-Benz safety car's body construction is a non-deformable passenger compartment. Here, the car has been loaded with 22,050 pounds on the roof. The springs have collapsed, but the doorposts and roof structure remain intact. Occupants are left full survival space.



The ESV out of Volvo has a front bumper with seven-inch travel, a steering-wheel mounting that is spring-loaded, pop-up head restraints, and air bags at the front and the rear.



In a frontal-impact situation, the Volvo engine is deflected downward at the firewall and rearward underneath the floorboards to prevent its intrusion into the passenger compartment. Engine mass cannot provide any help in absorbing impact.

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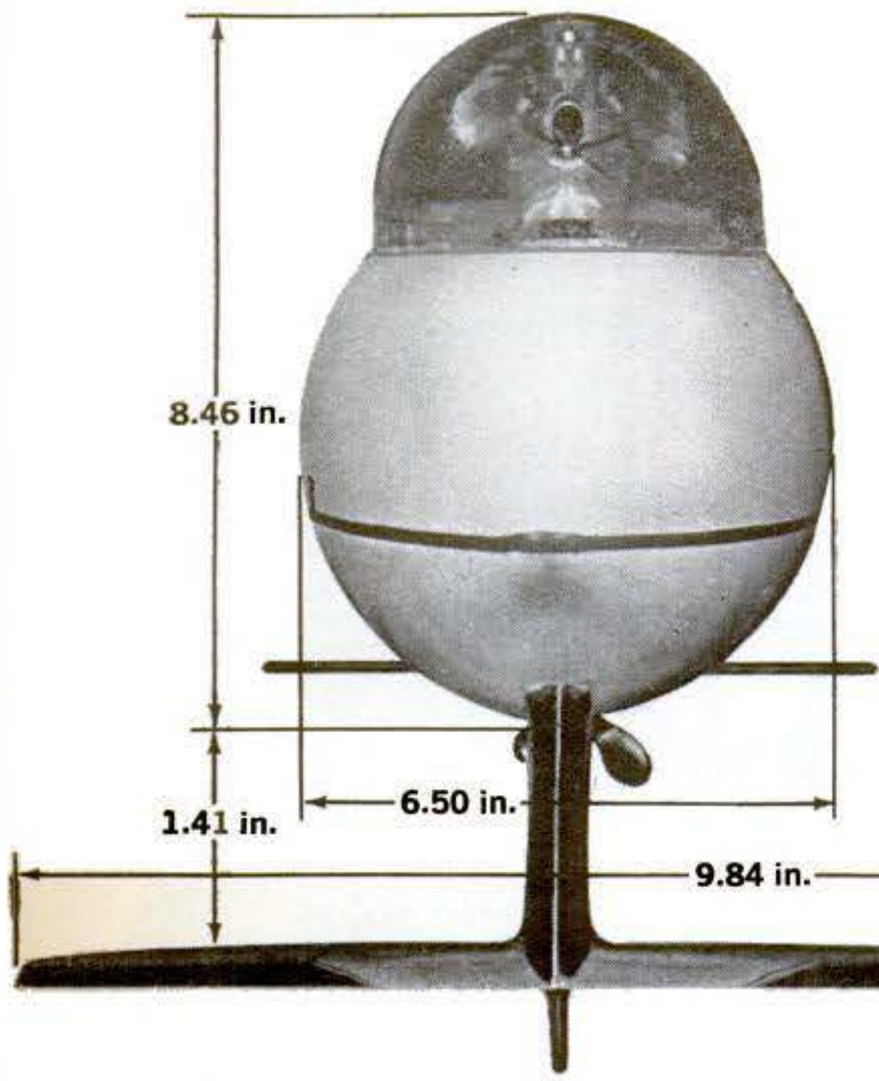
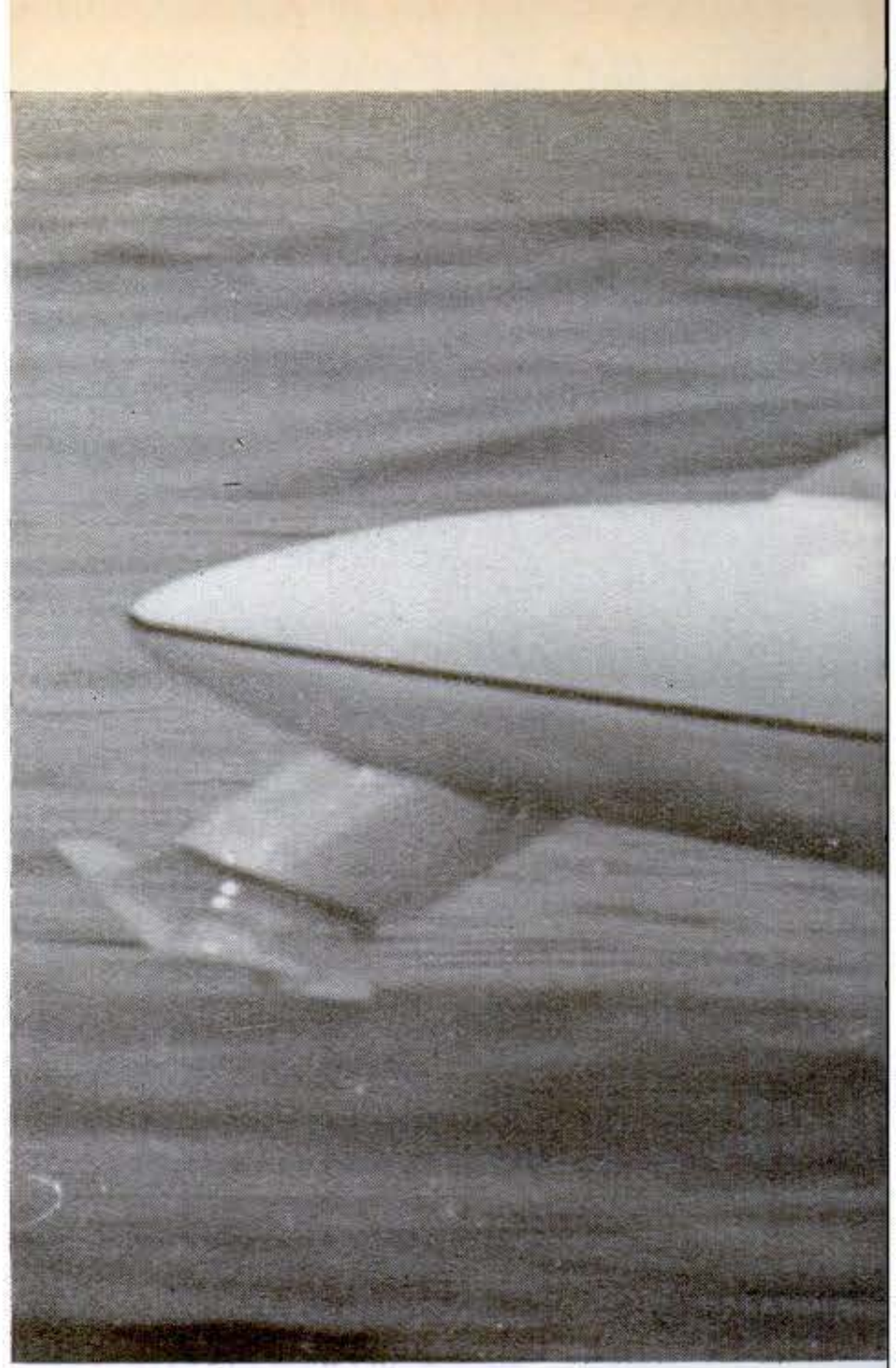
Dr. Wankel Re-Invents the Boat



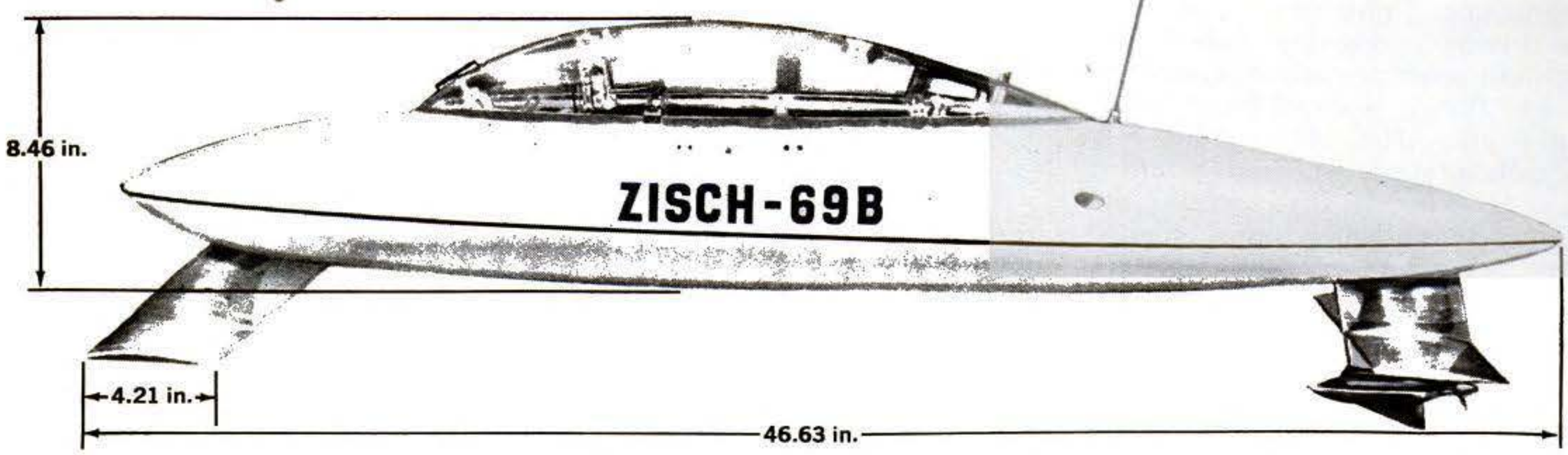
Felix Wankel's Zisch-boat can carry four persons at 60 mph with ocean-going capability

By MAX FEHLMANN
Automobil Revue

Torpedo-shaped hull with all-enclosed cockpit rides out of the water on stilts carrying glide flaps designed to cut through waves at the base and give the boat a flat, speedy ride.



Can the Zisch-boat do on water what the car does



A boat you can almost drive like a car on water? Sounds fantastic. Yet this boat exists, and has been tested successfully as a scale model. Two full-size boats are now under construction, and testing will start this month.

The inventor is Dr. Felix Wankel, the same man who built the rotary engine bearing his name. Today he is still developing the engine, but in his spare time he has been re-inventing the boat. He calls it the Zisch-boat. The word "zisch" is German for "zip." Propulsion is by a Wankel engine, of course, through a normal inboard/outboard drive.

Dr. Wankel has been toying with ideas for new types of boats on and off since 1937. Growing traffic congestion on land led him to revive the Zisch-boat project in 1962. Dr. Wankel thinks we must make better use of waterways and oceans for personal transportation, for mass transit cannot provide a complete solution.

Can high-speed private surface vessels compete with private aircraft and helicopters? In Europe, public use of waterways is way ahead of the private sector's interest in water. There are now regular services using air-cushion vehicles as well as hydrofoil boats on canals, lakes, and in the coastal areas of several countries. But there's nothing that can do on water what the car does on land.

That's what Dr. Wankel set out to change. He wanted to create a boat with the size, weight, carrying capacity, and speed of a passenger car, capable of travel on the high seas as well as in smooth waters.

Nothing like it has been done before. Just think of it: A four-to-six-seater, requiring a modicum of driving skill, able to cruise at the speed of racing hydroplanes or large hydrofoil boats, and to cover hundreds of miles in a day.

The Zisch-boat will do it. Scale-model tests, both in tanks and on Lake Constance, have proved its feasibility. Wave tests particularly show convincing evidence of its true ocean-going capability. The waves were created either by larger surface craft or by warm alpine winds. I have seen films made during these tests, showing the Zisch-boat in waves ten times higher than its length plummet into the water and resurface with little loss of either speed or stability.

I have seen demonstrations—in the tank—of its fantastic stability, provided by its low center of gravity and the high waterline at the tail. It will

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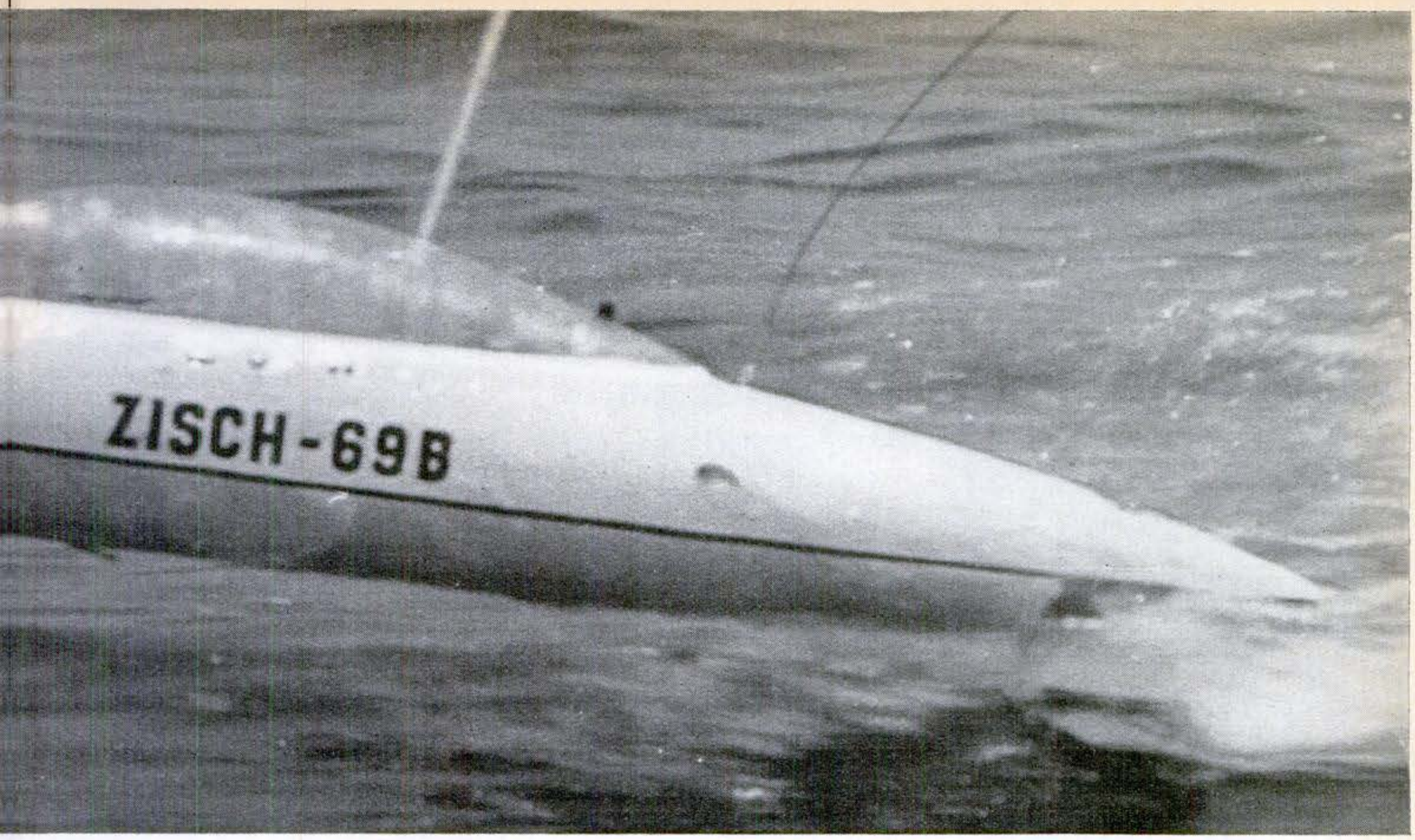

on land? Model skims along fairly smooth surface of Lake Constance at scale speeds corresponding to modern superhighway traffic.

return to its normal upright position when placed on its side on the water, and even when placed upside down in the tank. Riding the wave crest *sideways* on the lake once resulted in complete capsizing. Recovery was automatic, as a continued roll motion.

Now we know that it can be done, but Dr. Wankel did not know that until he had tested out his ideas. The Zisch-boat is not the result of one single new idea, but a combination of several new ideas. As in the invention of his rotary engine, Dr. Wankel showed fresh inspiration and completely original thinking.

The demands of ocean-going capability have kept all conventional high-speed small craft off the high seas up to now. The higher the requirements for rough-sea navigation, the broader, higher, and heavier the vessel. Horsepower requirement and building costs rise in proportion. The success of the Zisch-boat project depends on fulfilling two apparently contradictory conditions:

1. It must be small, but highly seaworthy.
2. It must be fast.

Clearly, hull shapes intended for constant surface contact would not be suitable. What, then—a submarine? No, a surface vessel, but borrowing something from the submarine. The hull is torpedo-shaped. If the Zisch-boat is to run in waves many times higher than the length of the hull, it will be completely submerged from time to time. The torpedo shape assures low drag, which means smaller speed loss during its moments of submersion.

Hull has a glass top. It's over the passenger compartment, enclosing the interior of the floating hull. What's new here is the absence of the usual boat accessories on deck and cabin, for any exterior equipment would be torn off.

The closed cabin was an absolute necessity. Any opening would rapidly fill the hull with water. That posed another problem. The occupants require ventilation, and the engine needs air. Dr. Wankel solved it with a simple device.

The air intake is located on the upper portion of the windshield. The opening is equipped with a valve that closes when the boat is showered or about to be submerged. The valve is controlled by a sensor at the windshield base. The sensor takes the form of a small airscrew. It spins freely in the wind. The spinning shaft sends a signal to the valve to stay open. When a wave hits the windshield base, the airscrew stops its rotation. Instantly, a signal is sent to

Continued

Inboard/outboard drive works as a rudder and steers the Zisch-boat with precision.

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Hull is submerged to waterline at standstill, but glide flaps lift it out of water on acceleration—quicker than conventional hydrofoils, and with less power needed.

close the air-intake valve. When the airscrew resurfaces, it resumes spinning, and the valve is reopened. The closed cabin has been successfully tested in full scale. It was mounted on a conventional motor boat, a British-built Avenger, and extensively tested in the North Sea.

But the hull was only part of the solution. Alone, the torpedo hull lacks the desired stability, flotation, and speed capacity. Dr. Wankel wanted a surface vessel (since air drag is so much lower than water drag). As such, it would have to fight the waves.

Conventional surface craft fight waves by pounding against them. Dr. Wankel found his answer in cutting them off at the base, and thereby maintaining the boat in a steady level position. How?

Naturally, he was influenced by the hydrofoil. Since hydrofoils have come into general use, a small marine revolution has taken place, both in civilian craft and military applications, to obtain higher speeds. Dr. Wankel could not learn any valuable lessons from the large hydrofoil boats, however, with half or fully submerged carrying elements. These ships obtain their relative seaworthiness exclusively through their size and power. A hydrofoil boat is not regarded as seaworthy unless it has a length of 10-15 percent of the highest wave height it can expect to encounter.

Hydrofoil boats with V-shaped or bow-shaped foils must be carried aloft at a distance corresponding to four or five percent of their length. And those with submerged foils need stilts so tall as to carry them out of the water at a distance equal to nine to 10 per cent of their overall hull length. These numbers show the size effects of Dr. Wankel's problem—for the Zisch-boat should be only 183-205 inches long and cost no more than $5,000, and yet have ocean-going capability.

How it zips along. Dr. Wankel began to experiment with new hydrofoil designs of his own. After several years, he had developed an extreme variant on the hydrofoil principle, a design best described as "glide flaps." As used on the Zisch-boat, the glide flaps are mounted as far apart as possible, with inclined stilts to support the hull. This corresponds to a car with a wheelbase longer than the body, which would give an extremely flat ride.

The shape of the glide flaps is of vital importance to their function. They do not ride the waves, but cut through them. In smooth waters, they just skim the surface. They have a wing profile with an absolutely flat bottom, set in an almost horizontal position. Under water, they have no more drag than a hydrofoil, but have larger surface, and correspond fairly closely to the flotation area of a boat with flat bottom, of similar weight, when running on perfectly smooth water.

At standstill, the Zisch-boat looks like a fish with only its tail in the water. Of course, the belly is also submerged. The important thing is that these submerged glide flaps soon rise to the surface as the boat gains speed, and bring the entire hull out of the water. Only the lower faces of the glide flaps are now in contact with the water, and the flaps no longer act as submerged hydrofoils, with low pressure above and high pressure below.

No cavitation. Their angle of attack (pitch) is unchanged. The maximum surface that produces drag is limited, in contrast with the hydroplane. The flap/water interface can never be larger than the flap surface. Waves that rise above the glide flaps are undercut by the flaps. Since the glide flaps are swept by water only on the lower surface, there is no formation of vortices or cavitation, such as can occur with high-speed hydrofoils (and result in failure of the equipment).

Cavitation is a result of steam bubbles forming from pressure differences in the water. Their collapse will cause pitting or larger holes on the hydrofoil surface. The same phenomenon can be observed on propellers of high-speed boats. The Zisch-boat's glide flaps do not give rise to such pressure differences. There is no lift force on the upper face of the flaps. The flaps are maintained on the surface by pressure of the onrushing water.

Early tests established the superiority of the glide flap with the flat underside over other types of hydrofoils. It was also found that the boat's behavior was greatly dependent on the pitch angle of the glide flap. By a change in pitch, the Zisch-boat could be changed from running at a fast trot through the waves to making long leaps in and out of the water surface. In neither case was there any substantial loss of speed, nor was there any pounding against the waves. Pitch movements were held within a tight range, parallel within a few degrees to the waterline.

In later tests, Dr. Wankel obtained proof that the effectiveness of the flap's lower face may be lower in laminar (smooth) water flow than when running against a turbulent water/air mixture. This is explained by the presence of air on the interface having the effect of reducing skin friction and therefore drag.

The transition from "swimming" to gliding (on acceleration) is accomplished much easier with the Zisch-boat than with hydroplanes, and with far lower power requirement. That is because the submerged glide flaps carry the hull's weight before they surface. Compared to hydrofoil boats, the Zisch-boat gets its hull out of the water quicker, because the glide flaps have larger surface.

When running slowly, or slowing down, especially with following waves, the hull and the flaps are intermittently shifting part of the load between them. The point is that these transitions are accomplished smoothly. When submerged, the flaps continue on a straight (horizontal) course, not affected by the waves. The torpedo-shaped tail of the hull also makes for added smoothness.

Now that the Wankel engine is revolutionizing the automobile industry worldwide, will we see a similar "Wankelizing" in boating? PS

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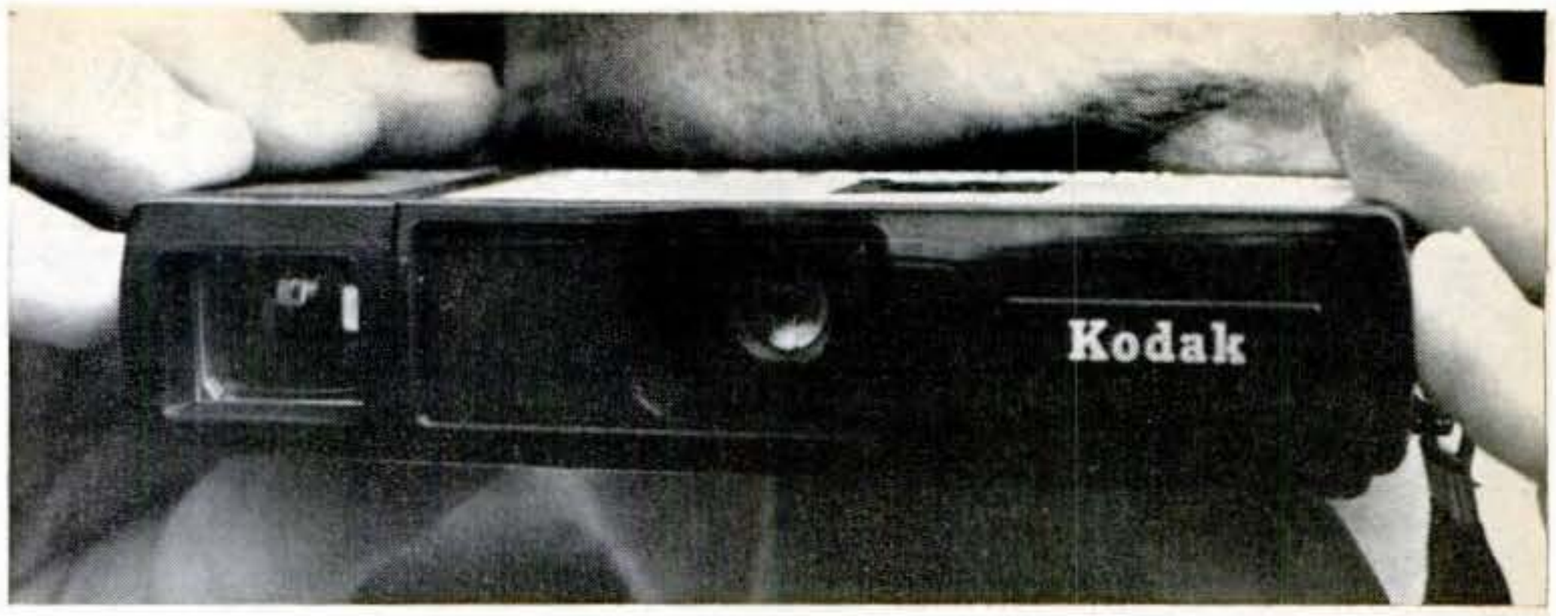
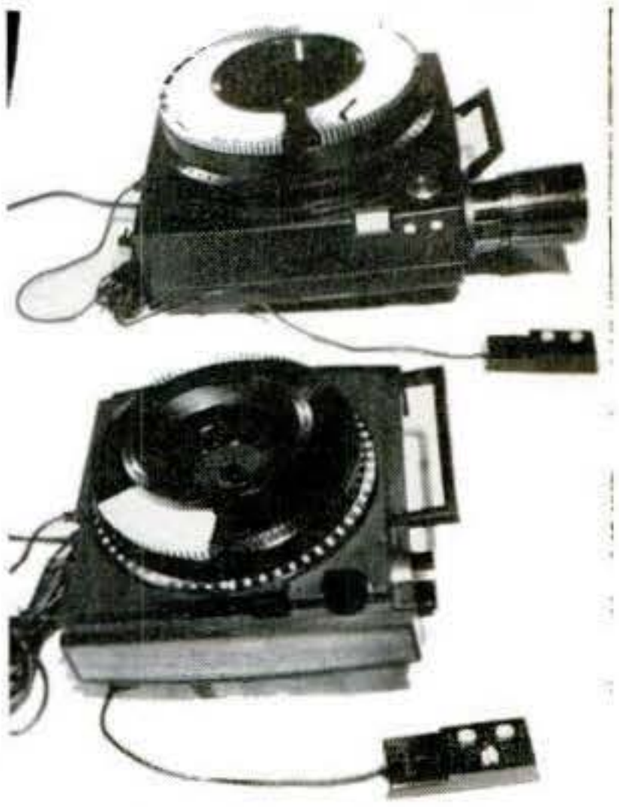
Kodak's New Pocket Instamatics

—and a system to go with them

Can't be bothered carrying a camera? Now there's a camera that's no bother

By EVERETT H. ORTNER
Group Editor, Consumer Information





Five new Pocket Instamatics are shown above. Prices run from $27.95 to $127.95. At right, Pocket Carousel Model 200 projector shows close resemblance to standard two-by-two Carousel above it—but at eight pounds, it weighs just a bit over half.

With 50 million cameras around the world shooting Kodak or Kodak-licensed Instamatic cartridges, you'd think those folks at Rochester, N.Y., would be satisfied. Not so. A *few* people, somewhere, haven't been taking pictures. Claim cameras are too big, or too nuisancy to carry.

Now they've got no excuse. There's a new line of five Pocket Instamatics designed to slip into a pocket or handbag with the ease of a pack of king-size cigarettes. To go with them, there's a new film cartridge, a new film, and a new line of projectors. Let's take a closer look.

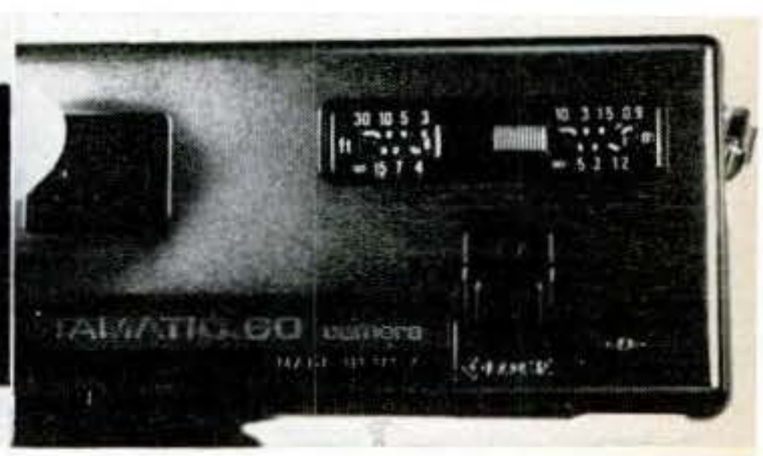
The cameras. All five cameras are lean, light, and pocketable: between 5⅛ and 5¾ inches long, about 2¼ inches wide, an inch thick; 5½ to nine ounces in weight.

Model 20 ($27.95) is the simplest, with a two-speed shutter (1/100 second for daylight, 1/40 with flash) and fixed-aperture lens. The others offer CdS automatic electronic shutters with time exposures down to 10 seconds. The two top-of-the-line models have a focusing f/2.7 lens, with Model 60 ($127.95), at the very top, offering a coupled rangefinder.

Magicubes, which need no battery (they're mechanically activated), supply flash. When using the Magicube, we recommend a Cube Extender, which raises the cube a couple of inches; with the cube too near the lens, there's a strong possibility of "red-eye"—reflection of flash from the

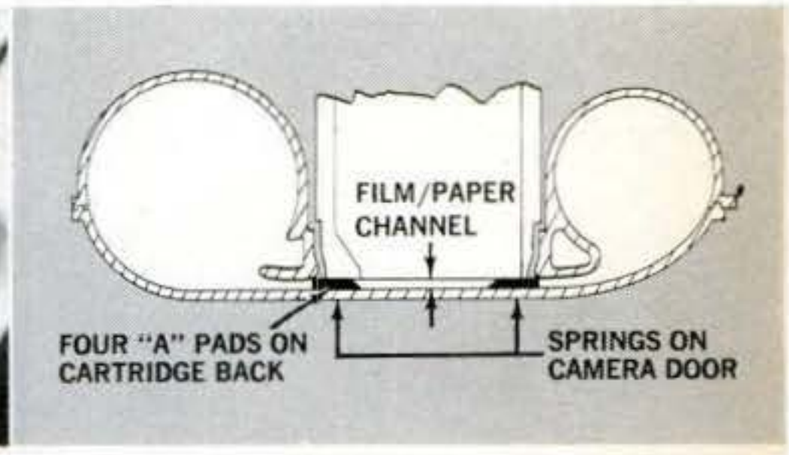
[Continued on page 126]

Window in back lets you keep track of shots —and for the forgetful, leaves no question of the type of film in the camera.



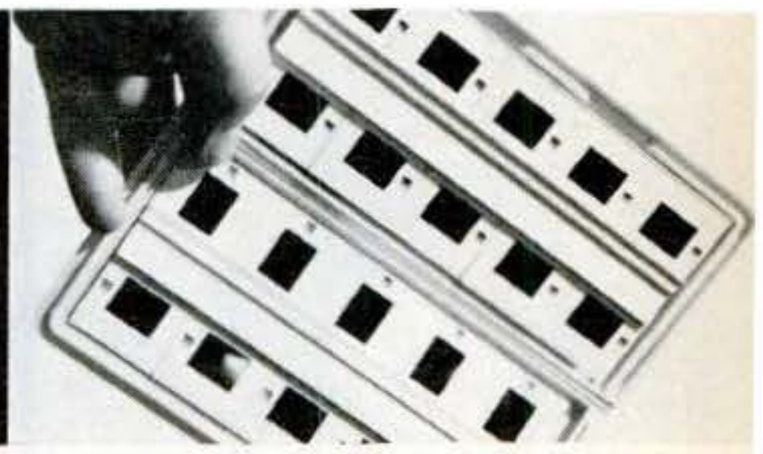
Sliding button on top focuses top-of-line models. On Model 50, focus is by guess; on Model 60, by coupled rangefinder.

New 110 cartridge is approximately three by one by 4/5 inches. A gear on take-up end (left) of cartridge winds the film.



Springs on camera door press against back of 110 cartridge to hold film flat in focal plane of camera, for sharper pictures.

110 films include Ektachrome-X, Kodachrome-X for slides; Kodacolor II for color prints; Verichrome (not shown) for b&w.



Slides are returned from processor arrayed on "sticks" in plastic wallet. Slide number shows through a cutout in mount.

Two New Electric Tractors—

Ten and eight-hp Electraks look alike, but E-10 has extra batteries. The E-8 will cut an acre per charge, E-10 one to three acres.

These Electraks are cheaper and smaller than GE's original "kilowatt" riders

By E. F. LINDSLEY / *PS Midwest Editor*

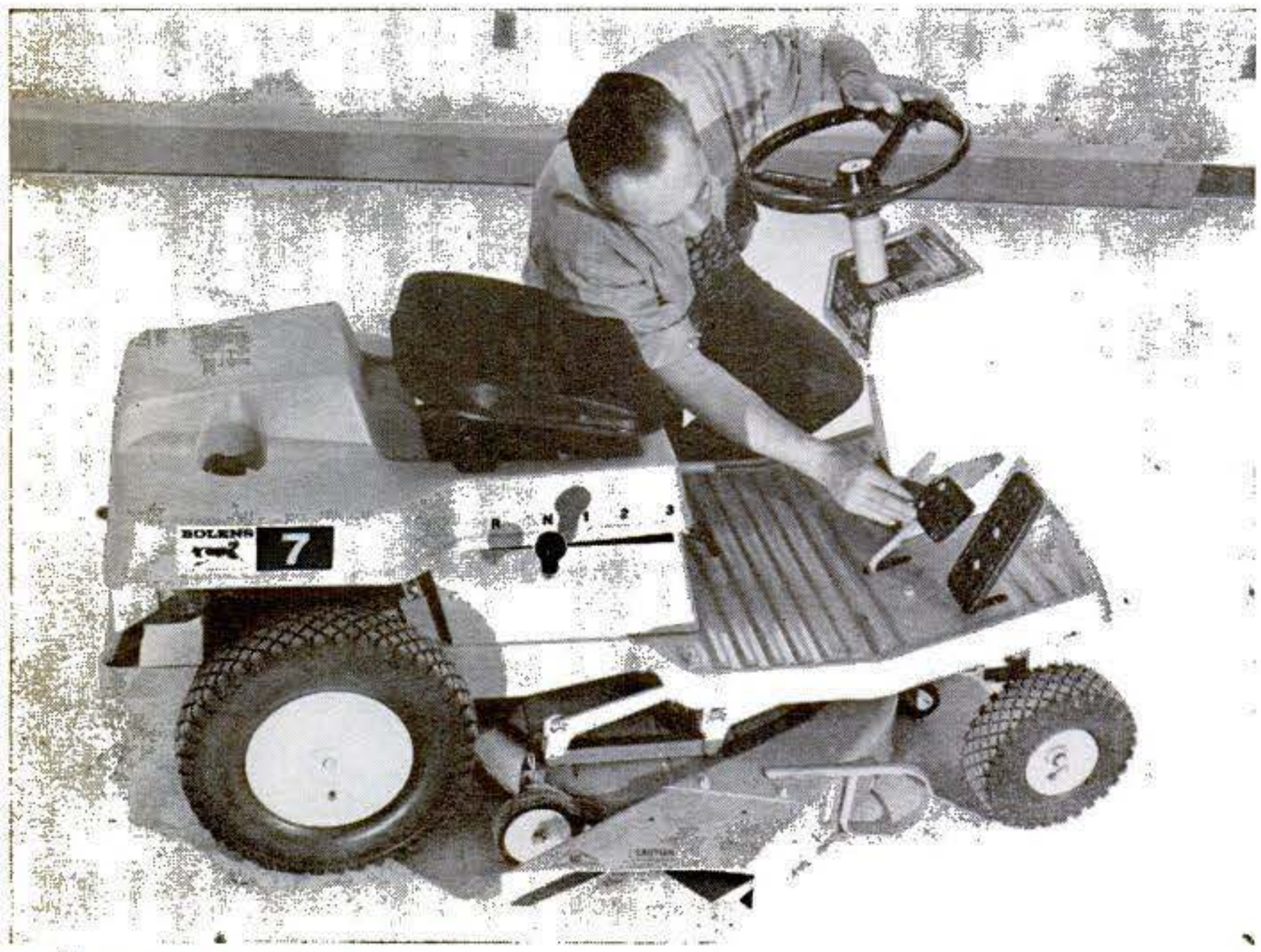
If you had a "wait and see" feeling about electric tractors when GE introduced its Electraks two years ago, you weren't alone. Would the batteries stand up? Would the operating time be too short?

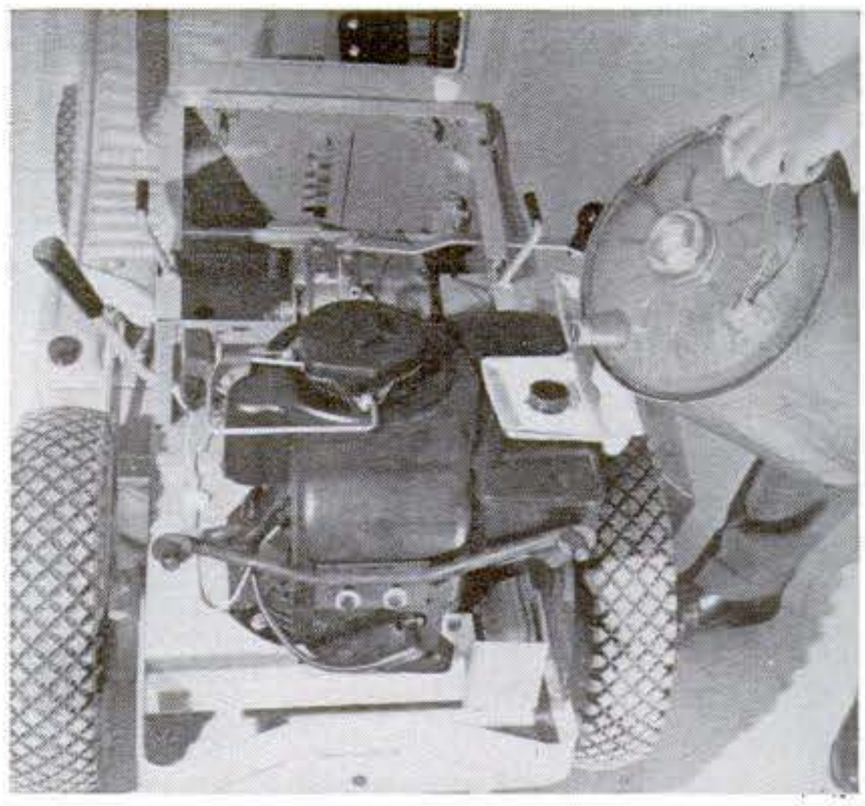
Happily, the tractors have performed as advertised. Battery failures have been almost nil—in fractions of one percent. Now, a bit flushed with success, GE is making two new models. They're smaller (eight and 10 hp) and cheaper. The E-8 sells for $795 and the E-10 costs $995. Add to that $180 for the mower, in both cases, and $269 for an E-10 snow thrower.

I tested both tractors on tough Florida grass. They did a fine job; and did it without fuss, noise, or special favor. They differed somewhat from the larger, original Electraks:

- Mowers are mid-mounted rather than front-mounted.
- The drive motor is constant-speed, not "throttling."
- There are three forward speeds and reverse from a selective gearbox.

OFF THE DRAWING BOARD AND INTO YOUR YARD:





Brake pedal on seven-horse Bolens rider must be down and locked to start (left). This prevents forward motion, and declutches and brakes mower blades. Photo above shows a clever little catchpan that prevents gas from running down onto the muffler. Runover splashes on the ground.

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No Fuss, No Noise, No Gas

• Deck lift is manual with six on-the-go adjustments.

You operate the electrics the same as you would equivalent eight- or 10-hp engine-powered tractors. Flip on the key switch and the traction motor starts. Depress the clutch and select your gear; release the clutch and you're rolling. To cut the grass, flick the switch to turn on the cutter-deck motors.

GE has gone out of its way to protect the careless or unknowing user. A safety switch under the seat insists that you be firmly in the saddle before starting, and it cuts all motors if you fall off.

I tested the Electraks for stopping and starting on steep hills. High torque can throw you like a motorcycle hill-climber if you roll back slightly before engaging the clutch. Battery position and weight with both tractors definitely prevented this. It was easy to let off the brake and let in the clutch to restart either forward or backward up a hill.

One problem was the rather tight underbelly clearance of the mower deck. This stems, in part, from the vertical height of the cutter motors. My lawn has some high rises around the root bases of a few old trees. I found a similar tree and stuck the tractor by running one edge of the deck high enough on the mound to leave the wheels spinning.

Both tractors have built-in, self-regulating chargers. When you're through working, plug 'em into a 115-volt outlet and forget 'em. Five hours later, the tractor will be rarin' to go again. The E-10 has six six-volt batteries rated at 180 amp hrs.; the E-8 has three 12-volt batteries rated at 85 amp hrs. Both front and rear compartments house batteries on the E-10, but the rear box is empty on the E-8 (until you use it for tool storage). Both mowers have 36" decks with two cutter blades. Each cuts about an acre an hour, and each has a top speed of 4½ to five mph.

Electraks in snow. For light snow on a stretch of sidewalk, the E-8 with a 42" dozer blade might be all you'd need. For heavier snow, only the E-10 offers the snow-thrower option. It'll clear two or three average 150-foot drives per charge.

Another feature offered on the E-10 only is the receptacle to plug in electrical lawn, garden, and hand tools. Options for both tractors include a headlight kit, lawn sweeper, and lawn cart.

How long will the batteries last? GE says its design picture was once-a-week use to full discharge for a period of eight years. About the only maintenance needed is checking and occasionally replenishing battery water. For outdoor storage on cold winter nights, GE suggests plugging in the cord for a trickle charge.

Replacement costs are reasonable. The E-10 battery package sells for $192; the E-8 for about $99. Divide this by the years of use and compare it to oil, gas, spark plugs, and repairs for the same time period. Even with power costs for battery charging, you'll probably save a few dollars. But better, you'll never need a can of gas or wake your neighbor on Sunday. PS

Six six-volt deep-discharge lead/acid batteries fill the front and rear boxes on E-10. Cord plugs into 115-volt outlet to recharge.

A Riding Mower Built for Safety

If you're a concerned consumer on riding-mower safety, you'll like the new Bolens 728. Its long development went from an experimental wheeled test-bed (only slightly less ugly than the Lunar Rover) into what now appears to be one of the safest, most functional riders on the market.

The 728 (from seven hp, 28-inch cut) started from scratch to bring together a multitude of human engineering factors: How ordinary users (not mower designers) drive a mower. How your reflexes respond in an emergency stop. Which body muscles best handle a deck lift. The design even takes into account errors commonly made in shifting, fueling, and starting a mower. Here's what I found:

• A deadman's brake when you release the clutch.

• A second emergency foot brake that also declutches and stops the whirling cutter blade almost instantly.

• A blocked reverse gate to prevent accidental shifting goofups.

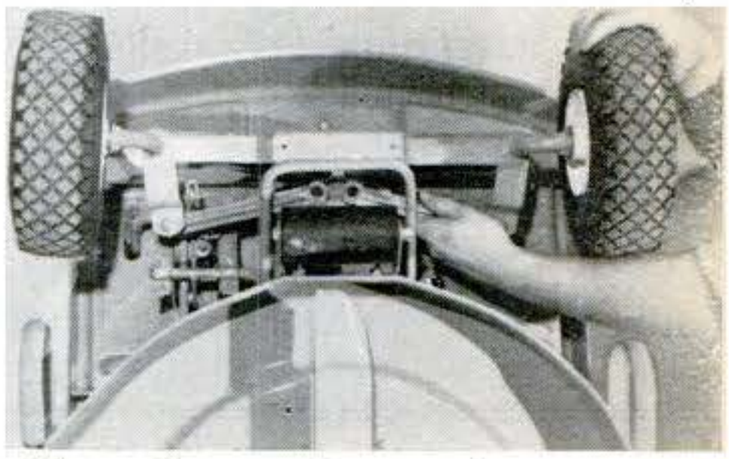
• A collector to channel spilled gas to a safe discharge point if you're sloppy when filling the tank.

• A spring-suspended seat that lifts off for service access, plus a lift-up rear deck of tough leathery plastic to help deaden engine noise.

Manual start is standard on the 728, and before tugging the rope you must set and lock the foot brake and turn the key. Once you're running and in the seat, disengaging the brake arms a seat switch. Leave (or fall off) the seat without first setting the foot brake, and the engine stops.

The automatic disk brake on the transmission output shaft is adequate for most routine stops. It also brakes the mower when parked—a good safety feature. But if you want to push the mower for parking, you have to hold the clutch pedal down.

Emergency stop? Jab the foot brake and three things happen: The drive clutch disengages, blade drive clutch disengages, and blade brake blocks pull the blade to a stop. Base price: $525. Bolens Div., FMC Corp., Port Washington, Wis. 53074. PS



Solid positive steering on the 728 comes from heavy ball-joint tie rods. All the wheel bearings have grease fittings.

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Flat left-front tire tread rolls under as car takes a sharp corner. Outer sidewall folds, but there's no risk of the bead becoming unseated.

Fail-Safe Tire Lets You Drive at

Incredible but true: go 50 mph for a hundred miles—safely—on a flat tire

By **DAVID SCOTT**
PS European Editor

Ever try cornering hard at 50 mph with a flat outside front tire? I did, and accelerated out of the bend to barrel down the following straight. It was at a race track in southern France near Marseille, where Dunlop recently unveiled its "total mobility tire."

This breakthrough in tire design aims to take all the hazard out of a blowout at speed, to remove the inconvenience of a simple puncture or slow leak, and to let you drive on safely at near-normal speeds for up to 100 miles. Dunlop will have it in production by early 1974.

The revolutionary Dunlop is a low-profile tubeless radial. It was designed to run flat, with normal inflation conditions engineered in later.

The specially shaped rim. This rim is only 60 per cent as wide as the tread. When the tire goes flat, the sidewalls fold, and the rim drops. Air pressure is not needed to hold this tire in place, for here the wire beads and rim profile are matched to do this on their own.

In addition, rubber-to-rubber friction would normally burn out the carcass in a mile or so. Dunlop licks this with lubrication.

Inside the tire is a 250cc sachet of brownish oily liquid of a top-secret formula. The capsule bursts under the weight of the car. The lubricant spreads out as thick film between the sidewalls and tread, which slip against each other at the rate of 20 feet per second when rolling at 50 mph. The friction is reduced by two orders of magnitude. In fact, the tire aquaplanes internally.

The liquid is also a sealant, and plugs punctured holes up to a quarter-inch in diameter. And that's not all. As the liquid warms up, it generates a vapor that automatically re-inflates the tire to four or five pounds, reducing friction further and stabilizing the ride.

Trying it out. I drove several cars with "punctures" on different wheels. With one rear tire flat I couldn't tell the difference. The car rolled true and smoothly—except when cornering away from the lame side. Even then there was only a slight sideways lurch as centrifugal force shifted

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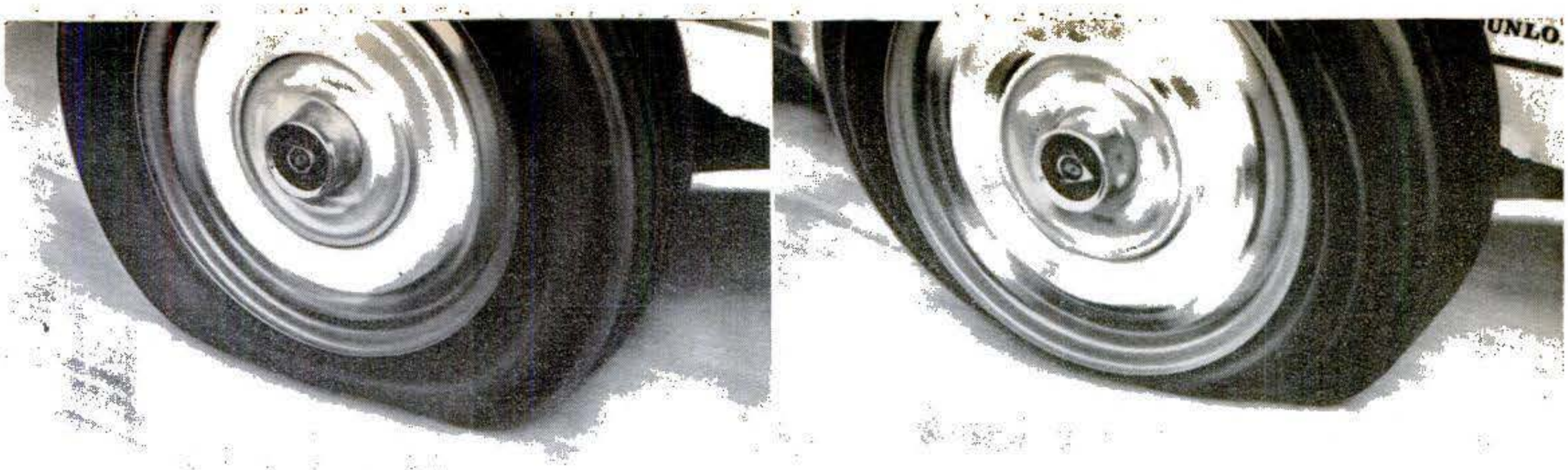
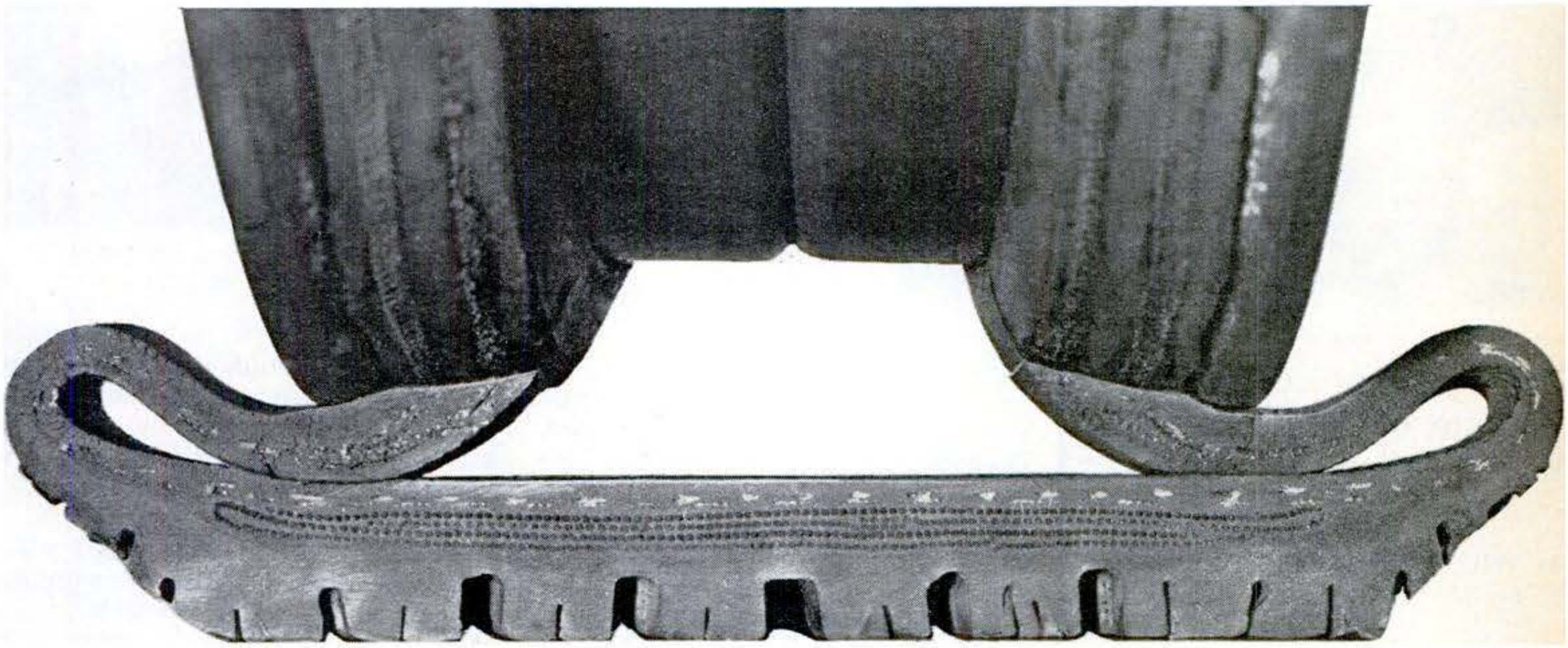


Flat tire rolls safely without damage on straight course. When cornering at 0.3-g lateral acceleration at 30 mph, the tread rolls under.



On deflation, sidewalls collapse straight down to let rim ride squarely on the tire tread. Then lubrication inside is added automatically.

Speed After Blowout

the outside rear wheel a bit across the folded sidewalls.

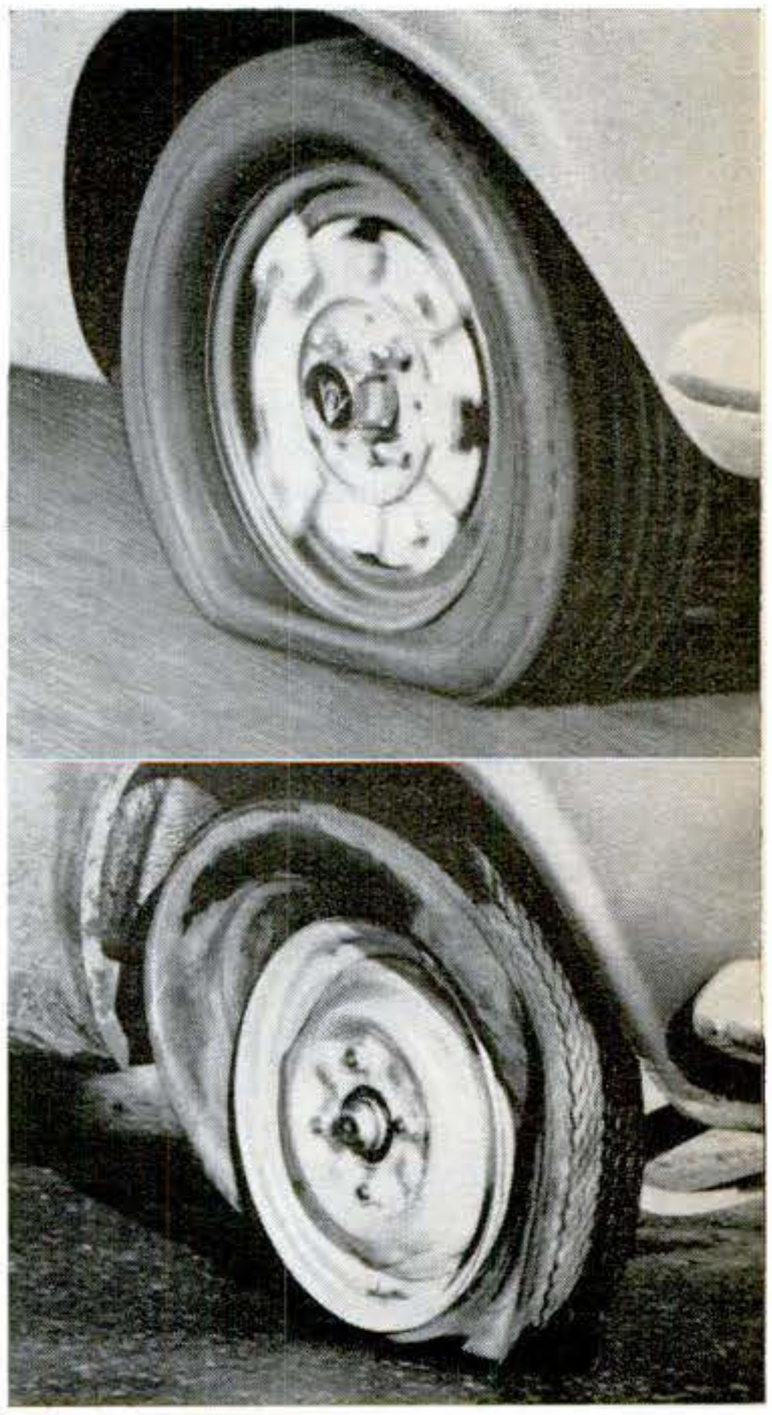
When the flat is in front there's merely a slight pull to the punctured side, and with hands off the wheel the car self-steers along a wide sweeping curve. You can hold it dead on course with one finger.

On a tight zigzag section I thrashed another front-flatted car to the limit around a hairpin bend. The madly displaced tread squealed in agony, but the rubber clung to the wheel—and to the road. We never bottomed on metal, and that could save your life in a nightmare situation

And the wheel? As yet the wheel for this tire is experimental and costly to make, and is used only for proving and demonstrating the concept. It has a flat steel rim integrated with the beads and sidewalls during pressing. A crimped inner flange, formed by squeezing the rim to narrow it after the tire is mounted, is then clamped to the wheel center.

For the future, the British Company, which is also Europe's largest manufacturer of car wheels, is working on a normal well-base wheel that will hold the beads on the rim without the possibility of their slipping down into the central channel and flying off in a puncture.

This Dunlop development goes further than the dual-air-chamber tires (as made by Goodyear and General) and may be a better solution than Firestone's experimental plastic ring inside the LXX tire. PS



Conventional tire (seen in lower photo) comes off the rim shortly after going flat, causing a badly damaged rim. The fail-safe tire (upper photo) stays firmly on the rim after going flat, without damage to itself or the wheel.

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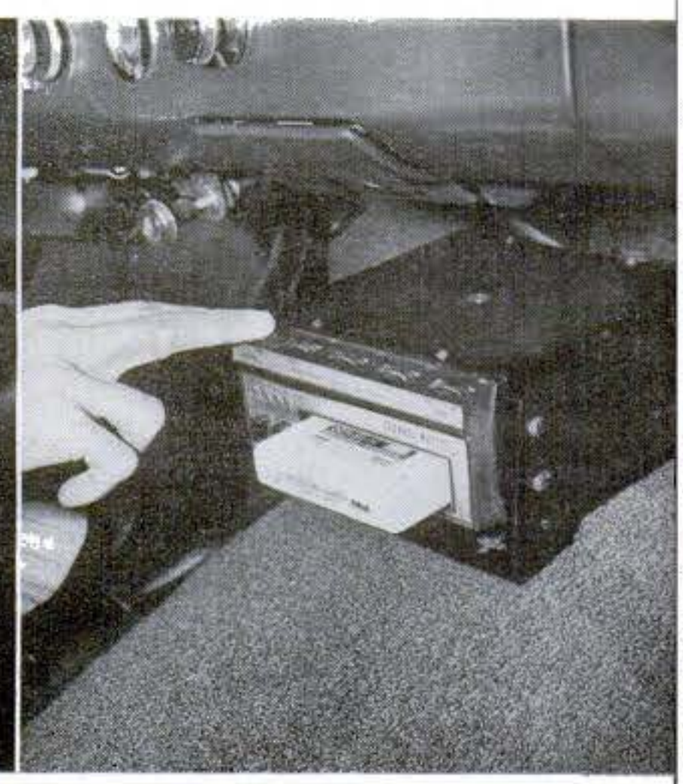
FOR CAR, CAMPER, OR BOAT
The New

Compact four-channel Automatic Radio hangs neatly from automobile dash.



With controls on top, Channel Master quad unit fits over hump.

Take your choice: cartridge, cassette, or FM stereo—and in two or four channels

By **WILLIAM J. HAWKINS**
PS Electronics Editor

For a lot less than a conventional hi-fi rig, you can have a music system that will follow you just about anywhere. For your car, camper, or boat, you'll now find a tremendous variety of sophisticated gear, including:

- Cartridge players for regular two-channel cartridges.
- A growing number of cassette decks.
- Stereo FM receivers—separate, built in to a cartridge or cassette player, or as an accessory plug-in.
- New matrix systems to let you get one type of four-channel sound from regular stereo cartridges, cassettes, or FM stereo broadcasts.
- A variety of accessories to make the basic gear even more versatile.

If you haven't had a look at mobile music makers lately, you're in for a surprise. You'll find not only a wide range of machines to choose from, but top-notch design and excellent value for your money. Among strong new trends you'll see:

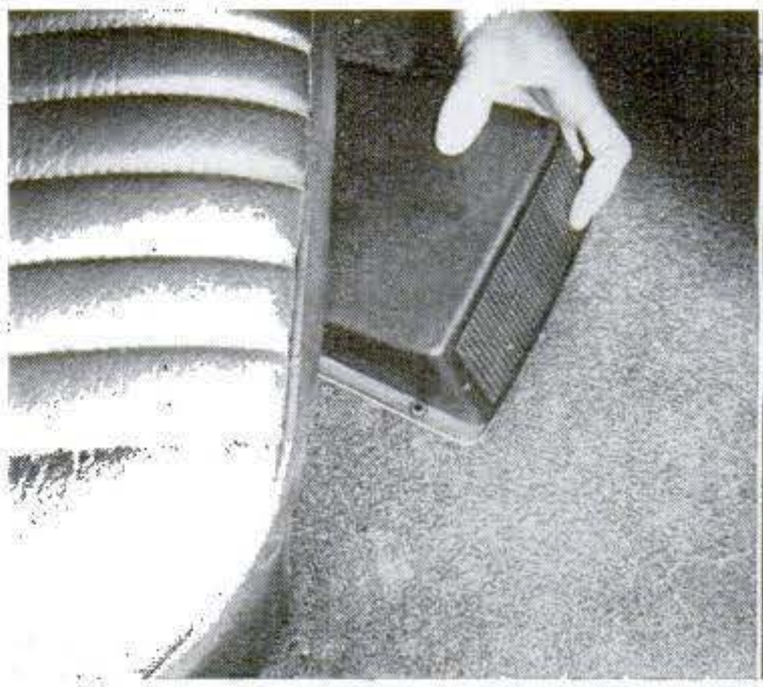
- More plastic than ever, along with aluminum and other lightweight alloys. The lighter construction makes installation easier, and it's more durable over road bumps and jolts.
- Better design, especially as it affects safety. Controls are kept to a minimum, and they're easier to find without taking your eyes off the road. Do-nothing switches, which only dress up the face of the deck, are out. You won't find a switch to reverse the left and right channels, for example, but you will find those necessary for adjusting channel volume, tone, and for changing tracks.
- New features. These decks sounded only moderately better to my ear. However, relays, solenoids, and pushbutton controls have turned many of the new models into semiprofessional transports.
- Attractive appearance. Multicolored pushbuttons and slide switches, handsome cabinetry, and bold marking make these units stand out in a useful way.
- Quality construction. The units we tried were not just built; they were engineered. Sturdy, dust-free decks are here.

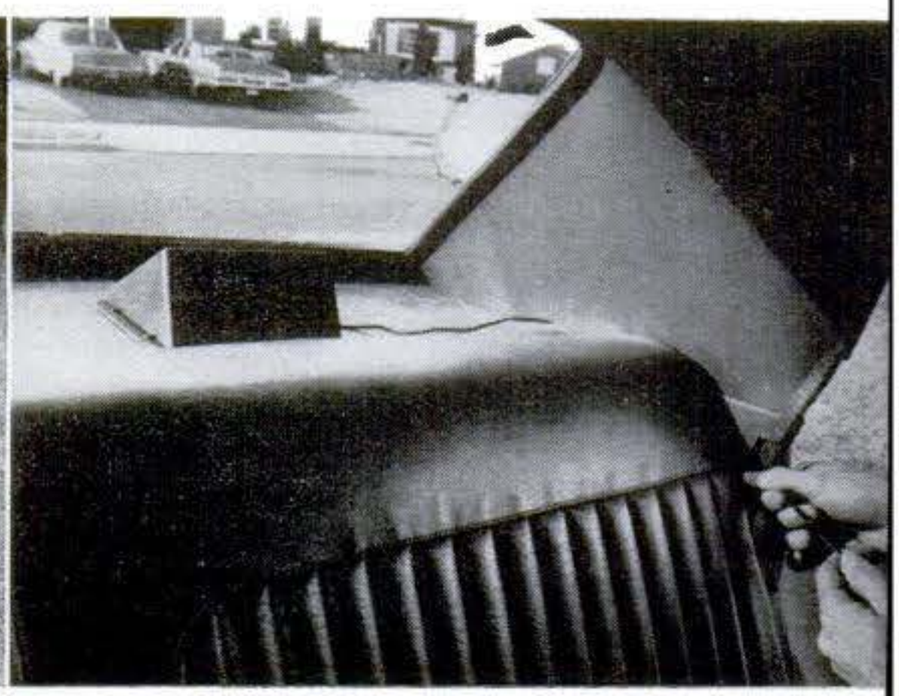
Cassette or cartridge? Cassette machines, getting popular in home hi-fi equipment, are moving into mobile service. Although cartridge players are still on top in sales, the cassette is moving up fast. Reasons?

Storage problems are halved with the smaller tape package, for example. A cassette can be run through a fast-forward or reverse cycle—something you can't do with a cartridge.

Cassette units we tried show that the smaller format can deliver excellent quality; the Musicruiser by Crown ($89.95) for example, produced good sound. And simple controls for balance, tone, and volume, with a single bar to reverse the tape or eject the cartridge, give it a sharp, clean look.

Of course, cartridge players have advantages, too. Discrete four-channel sound is available on cartridges—but not cassettes. And a number of new four-channel cartridge units are





Speaker installation is simple with slim-line baffled speakers. Two under front seat and two resting on rear deck complete system. Screws or tape hold them in place.

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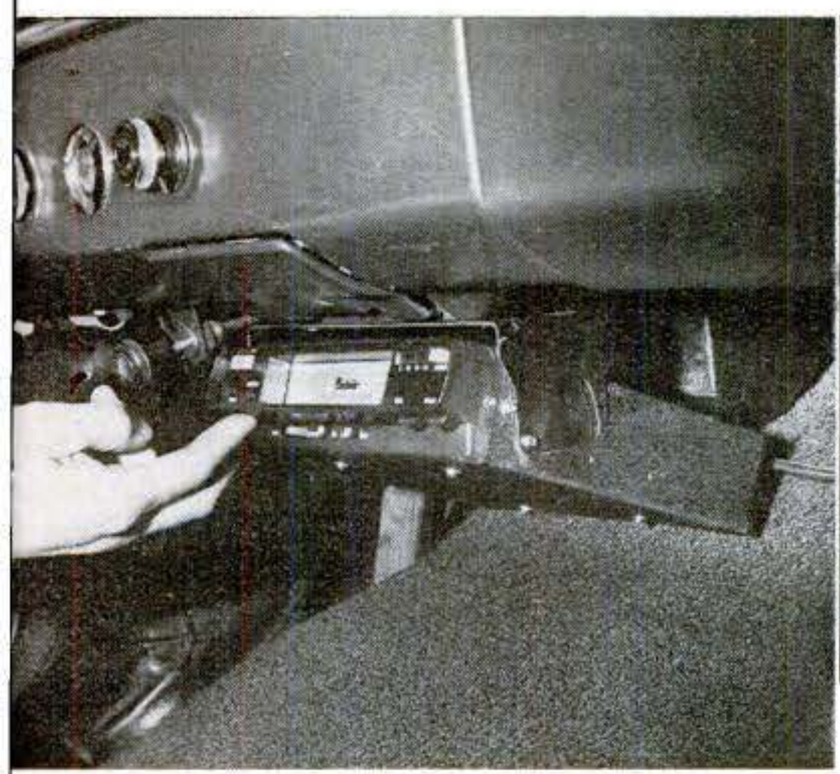
Take-Along Music Systems



Built-in FM stereo accompanies this eight-track stereo cartridge player from Belair.

Stereo Cassette player by Crown produces four channels with adaptor from Comm.

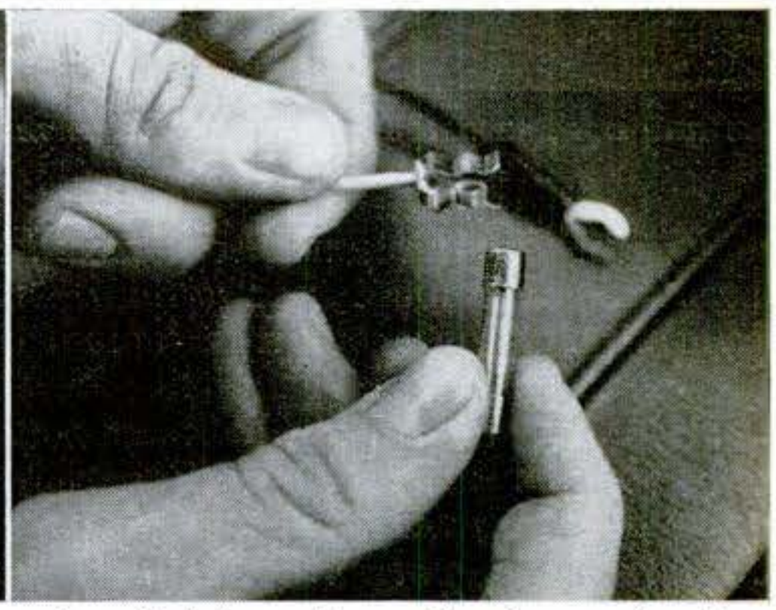
Play a cassette in cartridge machine? No problem with this adaptor from Astrosonics.

beginning to appear. (You can also get built-in FM stereo on some of these decks in case you don't already have it on your car radio.)

The Automatic Radio ($118.95), for example, is a two- or four-channel unit that uses slide controls for individual channel gain, master volume, and treble/bass settings. A channel button selects the tracks to be played and a repeat button lets you listen to the same track again. A pair of holes drilled under your dash lets you hang the unit neatly from its support bracket.

Also supplied with dash hardware is the Channel Master quad unit, ($169.95), but, due to the position of the controls, you can operate it just as well from atop the drive-shaft hump. Top-mounted dials control the volume and balance, while two pushbuttons select two- or four-channel operation and the track number. A couple of metal-tapping screws through the floorboard complete the installation.

Channeling in door still gives good protection to wires running to rear speakers.

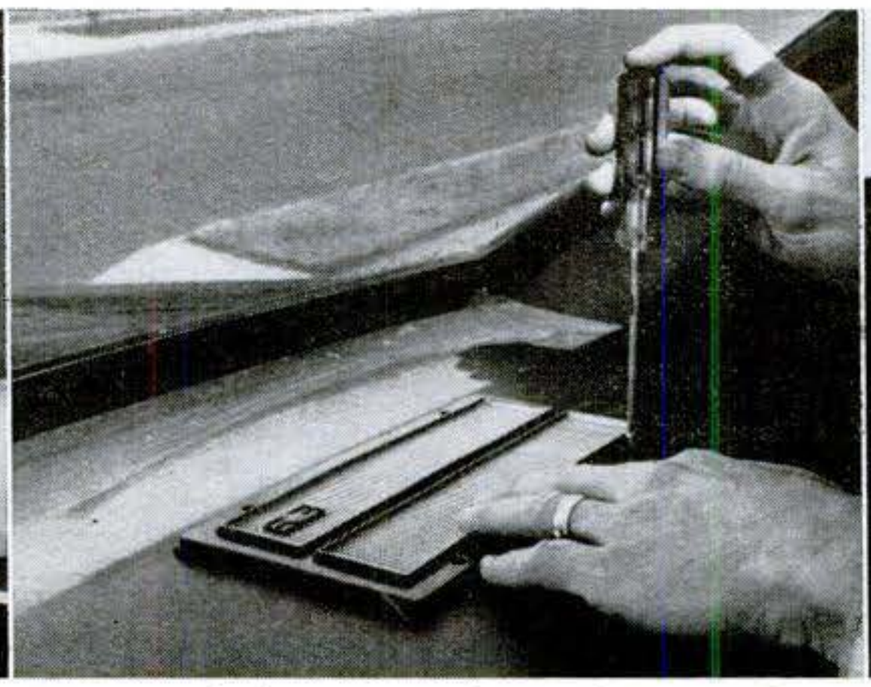


Discarded fuse clip makes battery hookup simple. Insert fuse, push into fuse block.

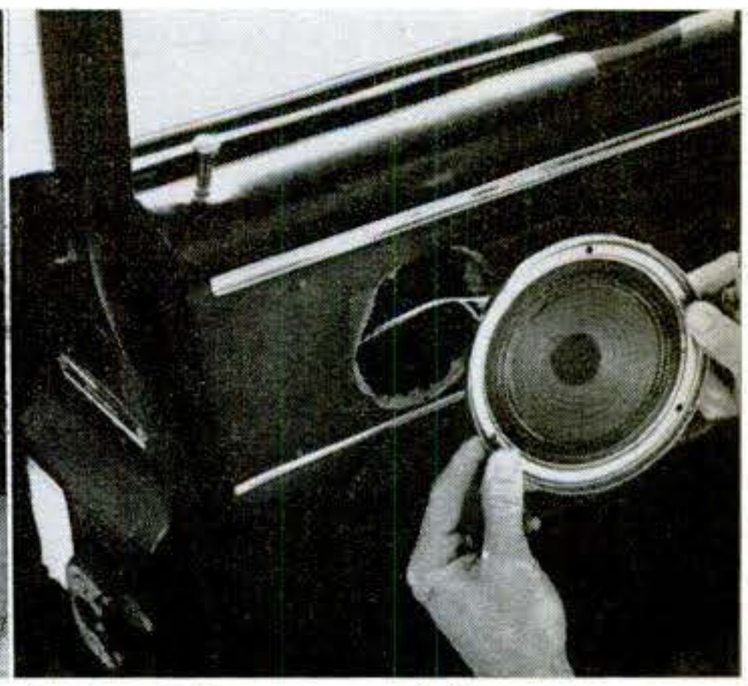
Tired of tape? Flip a switch and you've converted a Belair two-channel cartridge player into an FM stereo receiver ($99). A T-connection at your standard AM radio couples the deck with your outside antenna. Surprisingly, with all that's crammed in it, this is one of the more compact cartridge playback units available.

A couple of extras. If you want a cassette player, or if you already own a two-channel cartridge unit, you can still get four-channel sound with a simple add-on. A four-channel quad adapter by Comm Industries ($14.95) for example, adds four-channel "presence" to any two-channel system.

Kick-panel mounting is not difficult. Check for possible obstructions before cutting.



In rear deck, most of the work is usually done for you. Check for 6"-by-9" cutout.



Window-linkage access hole in door panel is large enough (if you're lucky) for speaker.

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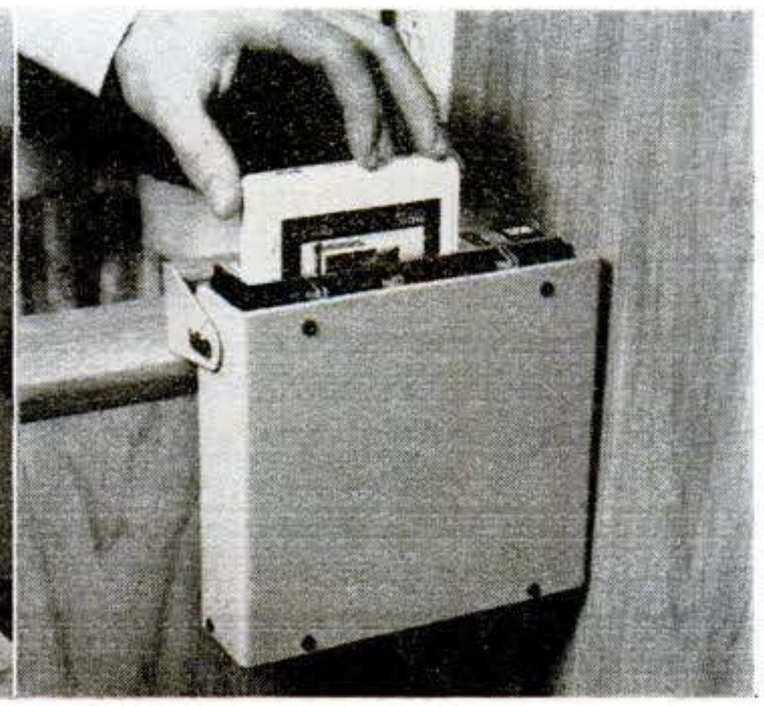
The device takes the out-of-phase signals from the normal two channels and feeds them to the rear speakers to create four. You won't hear four totally different sounds as you do with a discrete quad deck, but you do get a presence effect that adds to the realism of the music.

Another gimmick for your cartridge deck is a cassette adapter from Boman Astrosonic ($44.95). Want to play a cassette but only have a cartridge machine? Slip this adapter into the cartridge slot and place a cassette in the top. The adapter has its own playback head, motor, and preamplifier. It plays the cassette and couples the amplified signal into the deck, inducting through the deck's playback head. It works fairly well, but loses some high frequencies through the inductive coupling.

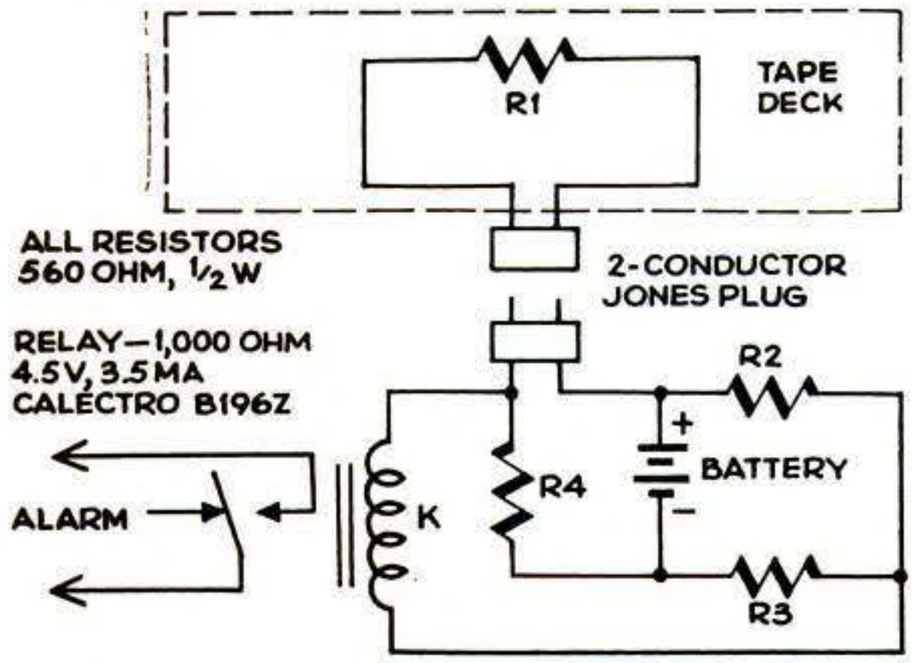
In your camper, an extra set of brackets will make this Afco a near-permanent fixture. Nearby power box keeps wiring short.



For a quick hookup, this lightweight Weltron just hangs on. Small molding piece on edge of ledge keeps unit from slipping off.

Temporary setup like this can be shifted outdoors or packed when breaking camp.

Add-on burglar alarm for any tape deck



Mount a connector on the rear of your deck and solder a 560-ohm resistor across the terminals. Solder a two-conductor cable to the mating plug; run the wire under the hood to an aluminum box containing remaining three resistors and relay. Shorting or opening the connection between deck and box unbalances the bridge circuit, closing the relay. Use relay contacts to activate the horn or a conventional alarm.

You can also plug a specially designed FM tuner the size and shape of a tape cartridge into the slot and get broadcast music out of your rig. Several companies have such units on the market.

The speakers. Mounting them in your car isn't difficult. Efficient hardware makes it a quick job. The simplest installation uses slim-line speakers enclosed in a plastic baffle which simply lie flat on a surface. Double-faced tape or screws will easily hold two under the front seat, two on the rear deck.

A second approach uses a speaker/grille-plate arrangement in the kick panels on both sides of the passenger compartment and in the rear deck. This, to me, is the best compromise of work and sound reproduction. Two or three screws hold the front kick panels in place with (usually) at least one steel support directly behind. With the panel removed, you should be able to orient the speaker to fit. If depth is a problem, you can buy special shallow speakers from $7 up.

In most cars, you'll see at least one or two six-by-nine-inch oval speaker cutouts in the underside of the rear deck. Use them. Don't try to cut the steel for a larger hole. If you want to use a smaller speaker, cut only a portion of the prepared section.

The last and most difficult area is in the doors. You'll need thin-profile speakers, but even with these you may have problems. Door panels have steel reinforcement walls behind, welded to the frame. The panels are easy to cut, but don't try the steel. Fortunately, there are access holes in the walls for getting at the window linkage. Drop the panel down and check the size of the holes. If they're large enough to accommodate your speakers, you're in luck. If not, try a different location.

Wiring a door-mounted speaker is a job in itself. Not only must you be sure the wire clears the window linkage, but it must exit safely through or around the door hinge without being crushed. The easiest way is to drill one hole in the inside door panel near the bottom, and a second in the bottom of the kick panel near the floor. The exposed wire should be just long enough to reach from the door to the kick panel with the door open. Closing the door will force the wire to bend inside the passenger compartment, away from the door hinge.

If you've decided on one of the simpler installations, you'll probably have an easier wiring job as well. You'll find no trouble in hiding the wires under the dash for the front

[Continued on page 125]

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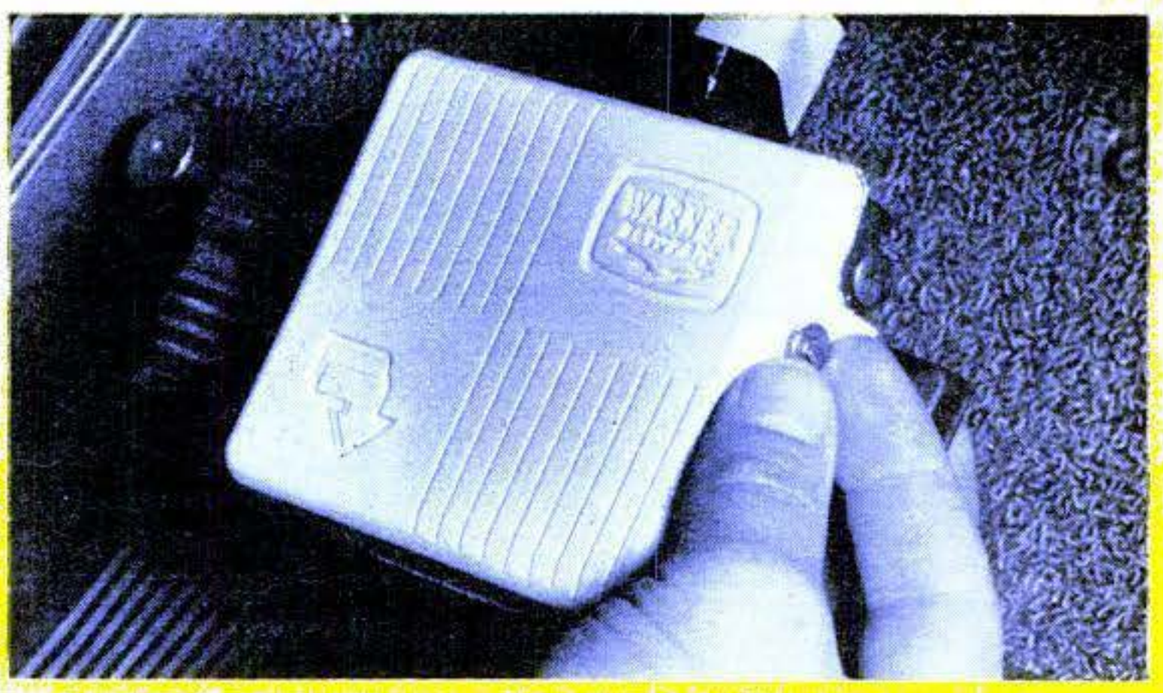
TRAILER BRAKES: PS Guide to Safe Stopping

Do you need them? What kind is best for your towing rig? Can you add them yourself? Here are answers to these vital questions—plus other facts you need to know to bring your trailer to a fast stop every time



Warner controller mounted on car's brake pedal (above) has no connection with hydraulic system. Light step on pedal applies only trailer brakes; heavy pressure brakes car and trailer simultaneously. Setscrew (right) adjusts trailer/car brake coordination.

By ERNIE HICKMAN

Tougher laws and bigger recreational vehicles are putting new demands on trailer owners and makers. States are now requiring brakes on more trailers, and even the federal government is considering new stiff rules for trailer brakes.

How does this growing maze of new regulations affect you? At what point should you demand brakes on your new trailer? Should you add brakes to your present, brakeless rig?

Car manufacturers offer some guidance. GM advises that all trailers of 1,000-pound loaded weight (or more) must have brakes. The 1,000-pound cutoff probably is the

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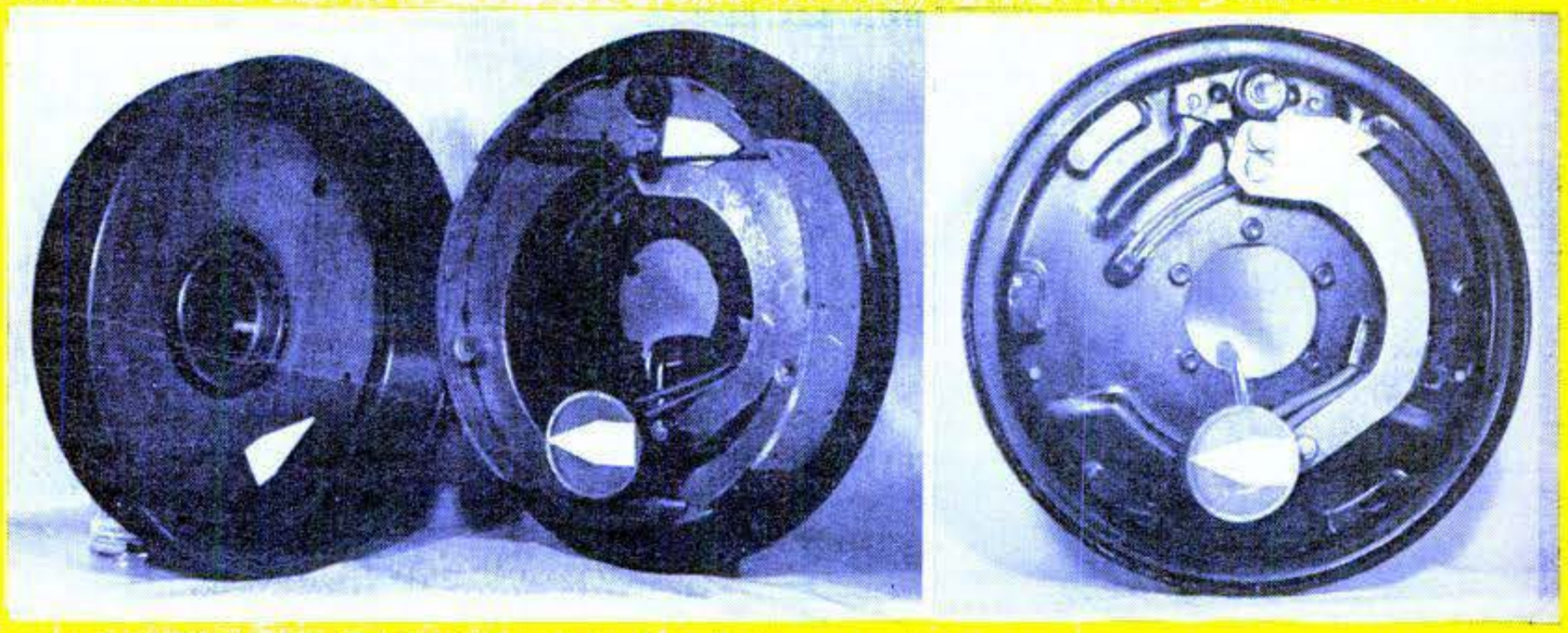

Electric trailer brakes use motion of revolving trailer wheel to force lining against drum. In interior view of Kelsey-Hayes system (right), arrows indicate direction of travel as arms and shoes operate. When controller admits current through electromagnet (disk on arm), the energized magnet is attracted to armature plate (inside of drum—arrow indicates direction of rotation), which rotates with drum and wheel. Magnet and friction pull lever, moving actuating block and forcing front shoe against drum. Arrows at far right show how parts move when current is applied.

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best rule of thumb. It meets all state laws except those relating maximum unbraked trailer weight to the weight of the towing vehicle.

Texas passed such a related-weight law last year, and other states are looking at similar ones. In Texas, your trailer needs brakes if its loaded weight exceeds 40 percent of the towing vehicle weight. That means a 2,000-pound subcompact car has an unbraked trailer-weight limit of 800 pounds.

POPULAR SCIENCE tests made with subcompacts and light trailers confirmed this as a reasonable point at which to require trailer brakes ["PS Tests Five Camping Trailers for Your Small Car," March].

Brake laws sometime fail to stipulate that load limits for unbraked trailers mean *loaded* rather than empty weight. If you buy a rig without brakes because the trailer's empty weight is a few pounds less than the legal limit, you could be in for a shock. Some trailers far exceed the unbraked weight limit—a fact some owners discover the first time they try stopping.

Many small camping and boat trailers fall into this category. Now, federal motor-vehicle safety standards compel manufacturers to certify the Gross Vehicle Weight Rating of their trailers—and where state laws make brakes necessary for that GVWR, the manufacturer equips his trailers accordingly. Because of the variations between states, the brake item may be optional or "required option" equipment. But it's a safe bet that whenever a trailer maker offers brakes as optional equipment, you'll be better off with the option.

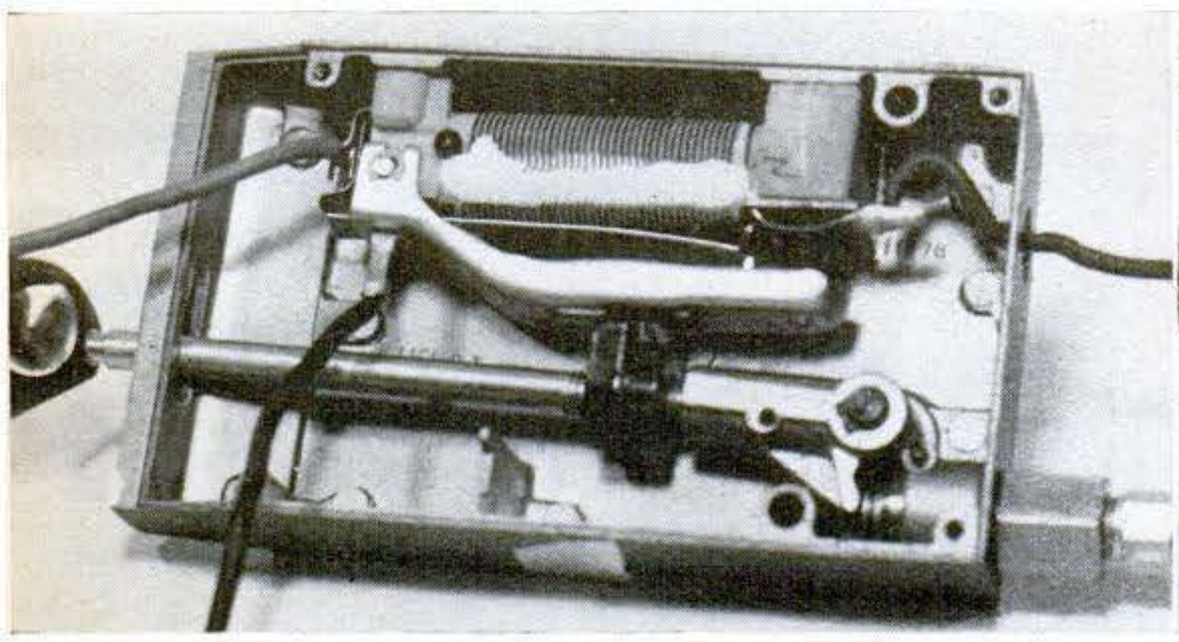
What kind of brakes should you use? Right now, the expanding-shoe, internal drum brake is the most common type used on trailers.

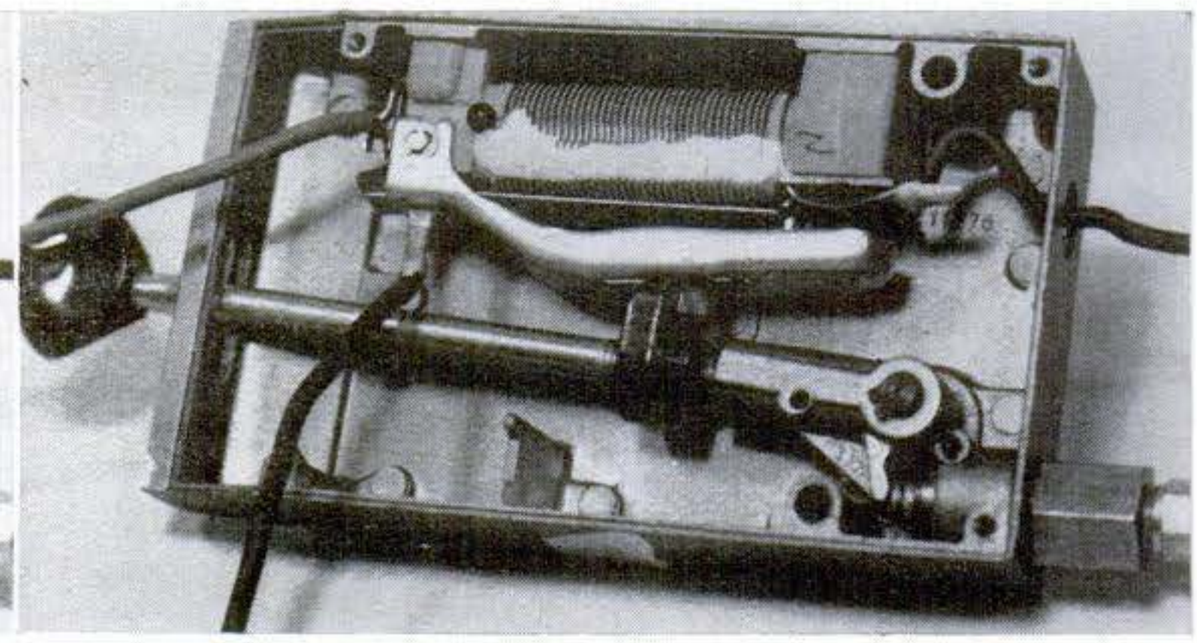
Almost all trailer-braking systems are either electrically actuated and controlled by automatic synchronization with the tow car's brake system, or they're hydraulically actuated and controlled by the momentum of the trailer as it surges against the tow car when the tow car brakes.

The most popular system is the automatically controlled electric braking system used almost universally on travel and camping trailers. Electric brakes use the motion of the revolving trailer wheel itself to force the lining against the drum. Riveted (or cast) within the drum of an electric brake is a flat steel disk, or armature. Facing that disk, and loosely fastened to the backing plate of the brake—the part that doesn't revolve—is a potent electromagnet.

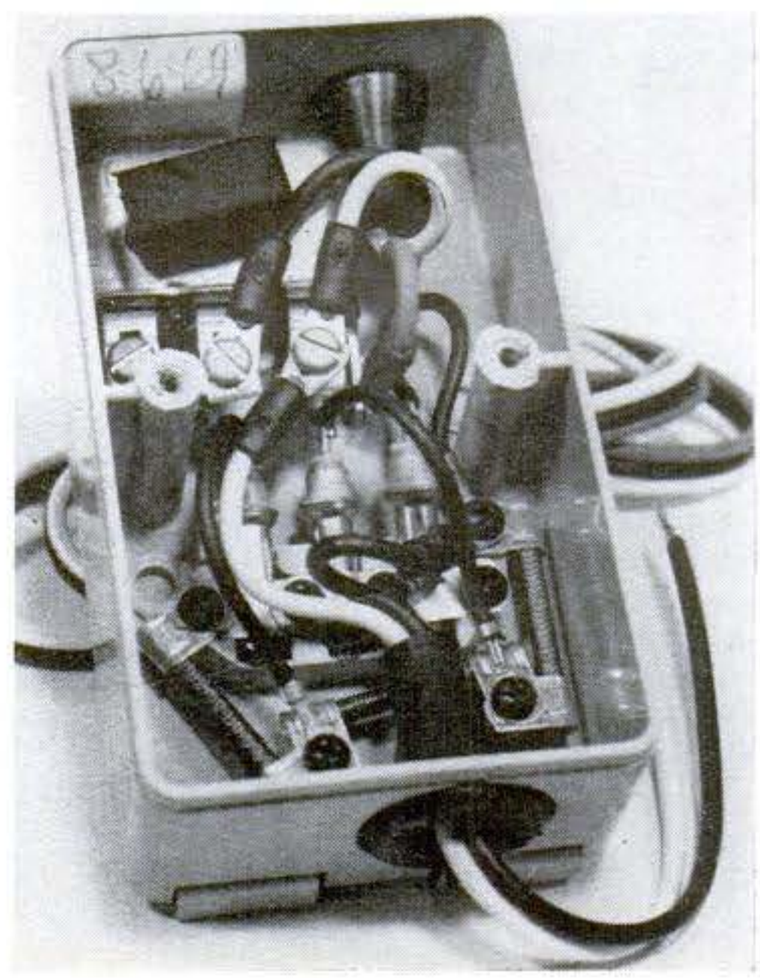
The brakes are applied by turning the magnet "on." The magnet tries to grip the revolving armature and turn with it. It succeeds within limits: As the magnet moves, the motion applies the brakes.

Once the primary shoe is forced against the drum, another characteristic of trailer brakes takes over. This is





Inside view of automatic brake controller: Hydraulic cylinder in lower left corner is connected to car's braking system. During partial actuation of brake current (left), the actuating arm, moved by hydraulic pressure, has pushed contact bar against several turns of the coil. This reduces resistance and increases current flow to brakes. During full application of brakes (right), contact bar is against full length of the coil, shorting out all resistance. The actuating block on the hydraulic lever can be screwed up or down the length of arm to alter synchronization. Knob at end of lever applies brakes independently.



Self-actuating electric brake controller fastens on the trailer tongue. Three leads in front connect to the stoplight switch, ground, and battery. Two at rear go directly to the brakes. Interior of the controller (near left) shows the relay tripped by the stoplight switch to turn on braking current. A trio of mercury switches canted at increasing angles short out resistance to increase braking current with increasing deceleration.

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you'll be better off buying them

servo, or "self-energizing," action. It's created by the friction that urges the brake shoe to move with the drum. This movement is transferred through an adjustable link (or band, in some Warner brakes) to a second shoe. An adroitly placed anchor acts as a stop for the servo-energized secondary shoe.

So the electric brake really is a servo-mechanism merely triggered by the electric current needed to energize the magnet.

The most common way of controlling this current is with a rheostat operated automatically by the car's brake system. A tiny hydraulic cylinder connected to the brake system does the trick. ("Tiny" is the right word; General Motors says not more than 0.02 cubic inches of fluid may be displaced by an add-on brake controller.)

This cylinder moves a contact lever across a coil, shorting out resistance as it moves; the more movement, the less resistance, the more trailer braking. The timing of the brake application can be adjusted by changing the location of the actuating block on the contact lever. Brakes can be adjusted this way to be applied earlier or later to match the brakes on the car.

The electric brake system may or may not incorporate one additional device. Some state laws require, and most safety-conscious trailer owners desire, a breakaway switch. This is a device mounted on the trailer tongue. In conjunction with a separate battery in the trailer, this device will set the trailer brakes—hard—if the trailer and car should become disconnected.

Hydraulic system—how it works. The other braking system, popular with boatmen, is the surge-actuated, hydraulic brake system. In this one, the hydraulic brakes are much like an ordinary car brake: A hydraulic piston forces a brake shoe against the drum. But with surge-controlled hydraulic trailer brakes, servo action often is limited to one direction. The reason is that backing up is a lot easier if you're not backing against the full effort of the brake.

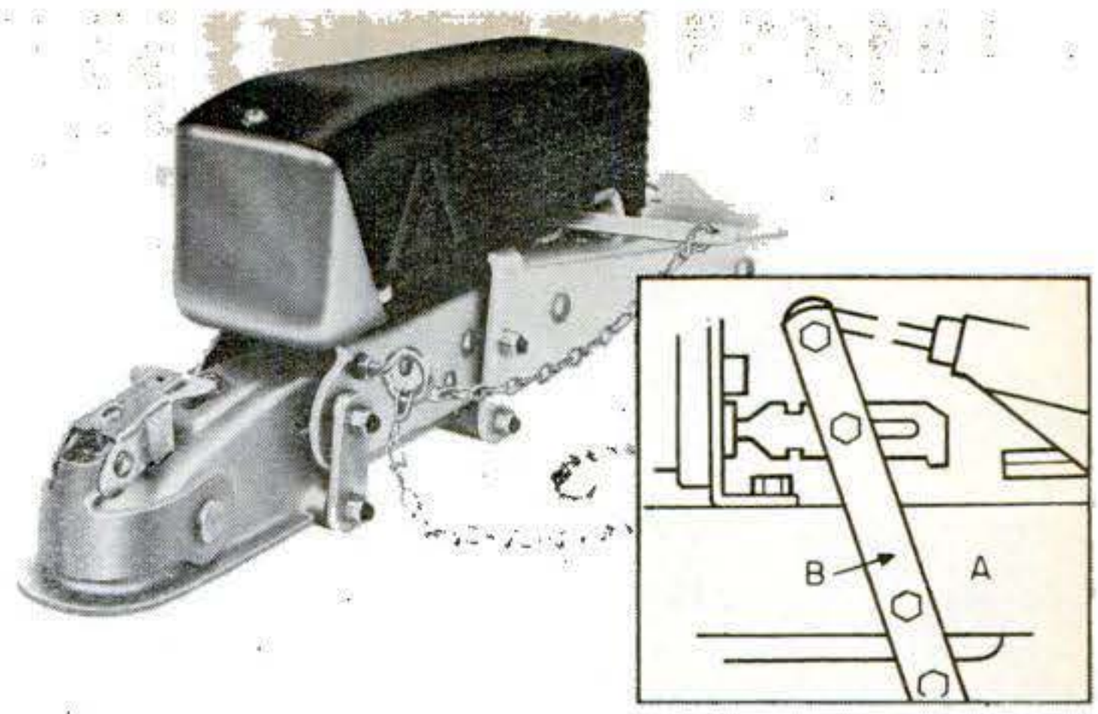
The pushing between car and trailer activates the surge controller, which is mounted on the trailer tongue. The ball coupler is attached to the tongue with some freedom to move back and forth, either at the end of parallel links, or of a telescoping tube. When the car brakes, the momentum of the trailer forces it forward against the coupler. This motion is transmitted through a lever system to the piston of the master brake cylinder. This applies the brakes, the trailer slows, and the normal coupler-tongue tension is resumed.

To forestall setting up an oscillation as brakes are applied and released, surge-controller manufacturers incorporate a modified automotive-type shock absorber to dampen the oscillating tendency and keep the brake action smooth. The system has a breakaway safeguard, too.

But surge controllers make special demands on equalizing-type hitches and antisway devices. There are tricky modifications available to match the many hitches and sway dampers to surge controllers, but they are not always readily available.

Hydraulic trailer-brake systems controlled by the car brakes and not needing a surge controller are still available, however. Stromberg Brake and Hydraulic Coupling Co. is the lone surviving manufacturer of these.

The Stromberg system uses a slave cylinder connected to the car-brake hydraulic system by a flexible hose. The slave cylinder couples to the trailer tongue and actuates a master cylinder there, which in turn actuates the trailer brakes. An auxiliary pedal and cylinder can be installed next to the car-brake pedal to permit independent trailer braking, and a breakaway actuator is part of the trailer master-cylinder assembly. But Detroit



Hydraulic surge-actuated controller like one above is popular with boaters. One made by Atwood is an integral part of trailer tongue. Drawing (inset) shows how it stops your trailer. As car slows, the trailer tongue (A) moves forward and applies pressure through the linkage (B) to the master cylinder. Pressure is transmitted to wheel brakes through the brake lines.

doesn't like it, and you use this system at your own risk.

The simpler coupling of electric trailer brakes, and their easier hitch requirements, would probably be enough to make them more popular on seasonal-use trailers, but electrics have something else going for them, too. Idleness is hard on trailer brakes; drums and operating parts rust. And hydraulic systems seem to suffer more from disuse than electrics do; frozen cylinders, pitted pistons, rotted wheel cylinder rubbers show up more often in long-idle hydraulic systems than in regularly used ones.

The electric system also has independent operation going for it; being able to control the trailer brakes either with or without the car brakes is a big advantage. So is the fact that electrics can be adjusted to take hold just a mite earlier than the car brakes; this is a time-honored system of keeping the trailer securely behind the car.

Here's how to make this adjustment. Take the car/trailer rig out on a dirt or gravel road, make a few low-speed, locked-wheel stops, and check skid marks. When the brake system is balanced so that the trailer wheels start to skid just before the car wheels do, adjustment is perfect.

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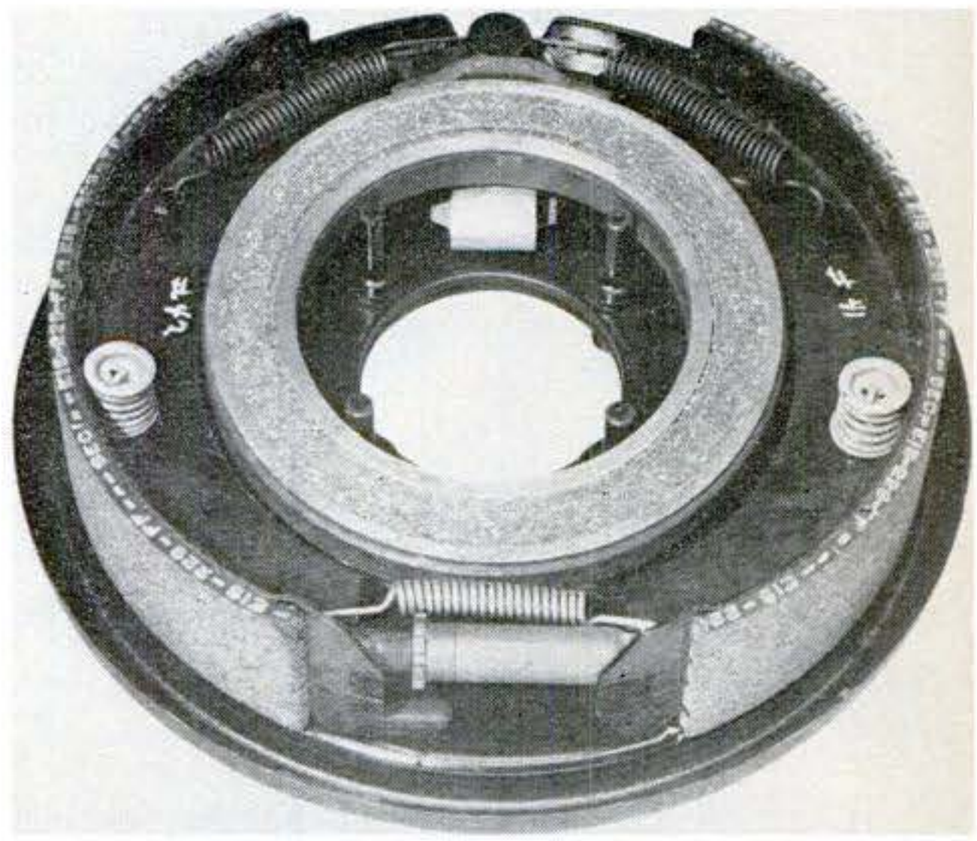

Warner electric brake has doughnut-shaped magnet surrounding axle spindle. Its actuating lug is on outer circumference. When energized magnet tries to revolve with armature, actuating lug is forced against brake shoe, which in turn is shoved against drum.

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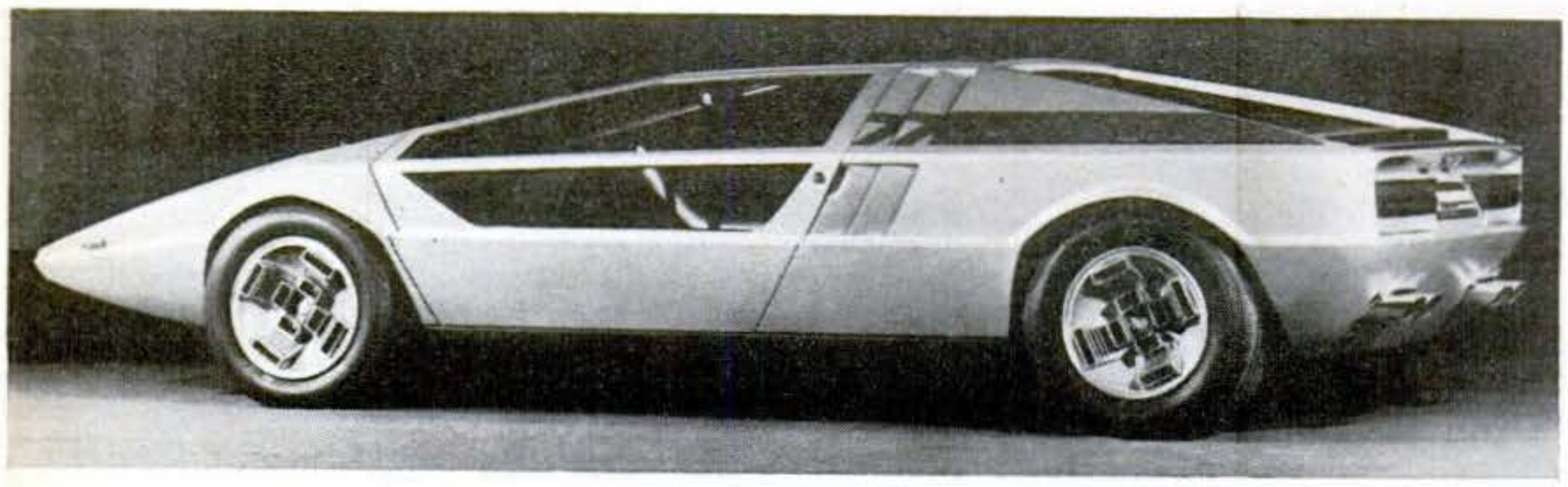
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Wiper-washer

Dirty headlights? Press a button and this German device sprays the lens with water as a wiper swings out from the rim to make two revolutions. Cycle takes eight seconds. From Auto-Technik KG Berlin-Koln, D-5000 Koln 1, Neue Wyerstrasse 10, West Germany.

Two-seat bullet

Tapering smoothly forward like a bullet, Maserati Boomerang by Ital Design is 3½ feet high. A mid-mounted 310-hp V8 pushes it over the road at a whopping 185 mph. The wrap-over doors have fixed upper windows, wind-down lower panes. Seats? Two reclining buckets. What else?

Ball retriever

Has the golf-ball-in-the-water problem been solved? Trap-It, a cast-aluminum cup with telescoping shaft may do it. Place the cup over the ball and a sliding pin goes up and down to snag it. A nine-foot Trap-It is $5; a 12-footer, $7. C.I. Industries, 3210 N. Pierce St., Milwaukee 53212.

Smooth shaver

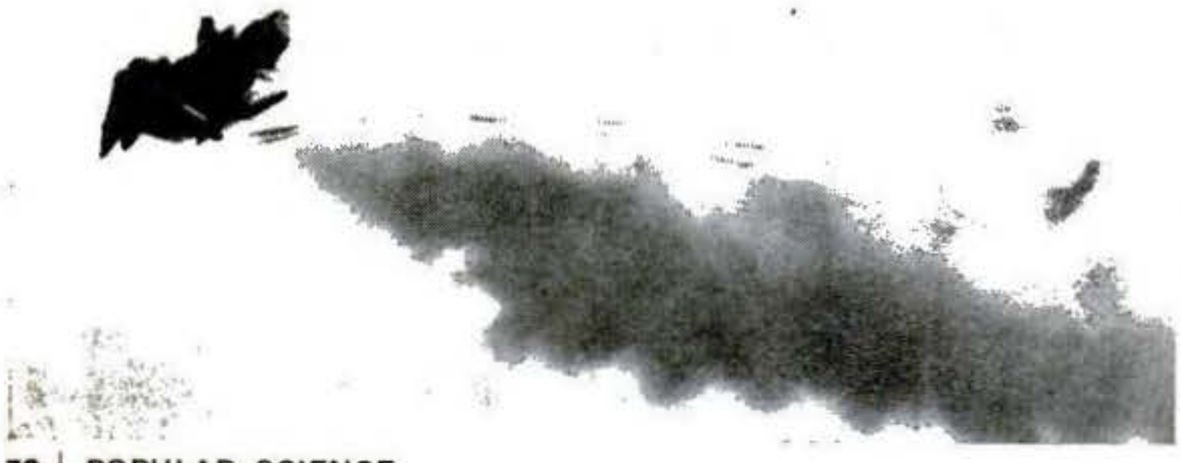
A long, lean handle for easier holding, a longer-lasting motor, and two contoured heads for smooth-cutting—that's what Sunbeam claims for their SM7 shaver. It has a sideburn trimmer and comes in a hard-finish travel case. Price: $33.50.

Flash trigger

No long cords needed to trigger a second flash unit. When the master flash on your camera fires, Spira Slave sets off the auxiliary. It won't react to ambient light, needs no batteries, attaches with a suction cup. $9.45 from Spiratone, Inc., 135-06 Northern Blvd., Flushing, N.Y.

Ticket timer

Parking meters in Paris are taking on a new look. This one delivers a ticket that gives the arrival time and the parking time allowed for the money paid. The ticket is then placed on the windshield for checking by the gendarmes.



Fleet seat

Two seconds after a pilot pulls the ejection handles, he's outside under an inflated parachute. Developed by McDonnell Douglas and called ACES, the new rocket-powered system is estimated to be effective at an altitude as low as 200 feet—even if the plane's inverted.

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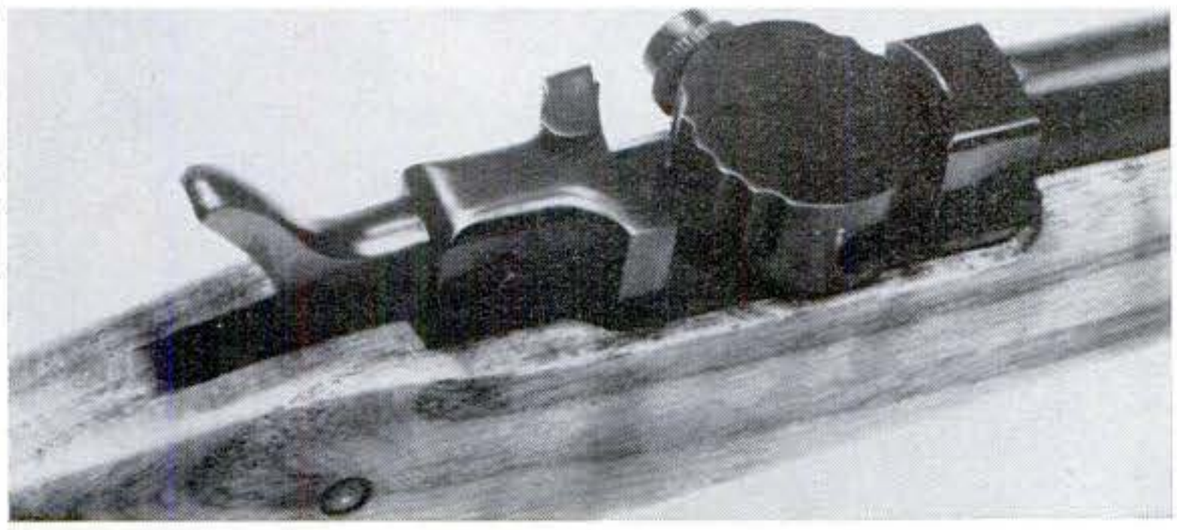
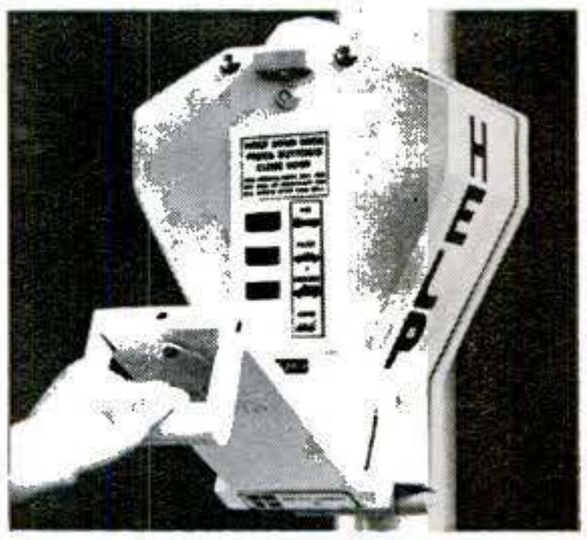


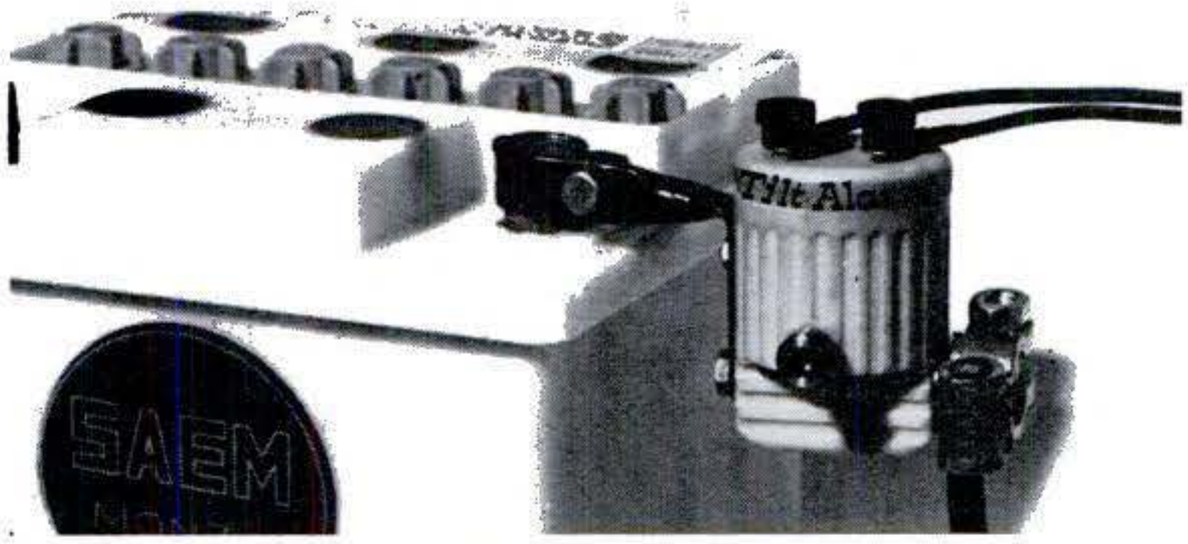
For fast breechloading: a rotating turret

Load in seconds? Fire 250 shots for a dollar? That's the claim of the Rocky Mountain Arms Corp. for their new black-powder breechloader just going into production. To load, you pour a loose powder charge into a fixed-capacity chamber in the rotating turret, push a ball over the charge, slip a cap-pistol paper cap inside the nipple cover at the other end of the turret, and spin the turret to firing position. The ball can't be loaded from the muzzle—it's too big. A swaging cone shapes it to fit the rifling. Rifle calibers: .22, .36, .44. Rocky Mountain Arms Corp., Box 224, Salt Lake City, Utah 84110.

Self-buckler

There's no buckling with this English seat belt. No leaving it off, either. Open the door and the belt automatically lifts clear of the seat. Close the door and the belt wraps around the driver. Secret: a motorized reel. Auto Restraint Systems, 39 Fitzroy Square, London W1P 6AX.



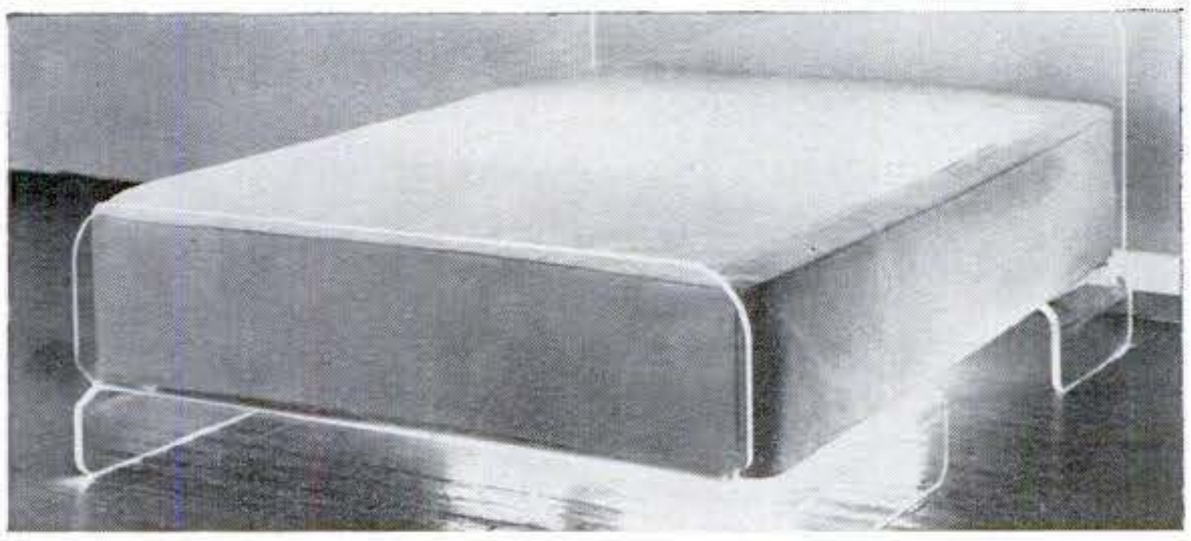


Battery shutoff

Run one battery cable through this mercury switch, and two things happen in a crash or a roll-over: Juice is cut off to the distributor cable (to prevent fire), and horn and brake lights are activated to warn other motorists. Ferrario, Viale Lombardia 1, 20056 Trezzo Sull'Adda, Milan, Italy.

Pushbutton call box

Aid for motorists just seconds away with this new roadside call box from ADT. Four buttons labeled Fire, Police, Ambulance, and Service activate the unit's solid-state FM transmitter. The box operates without batteries; opening the door generates electricity for the radio.

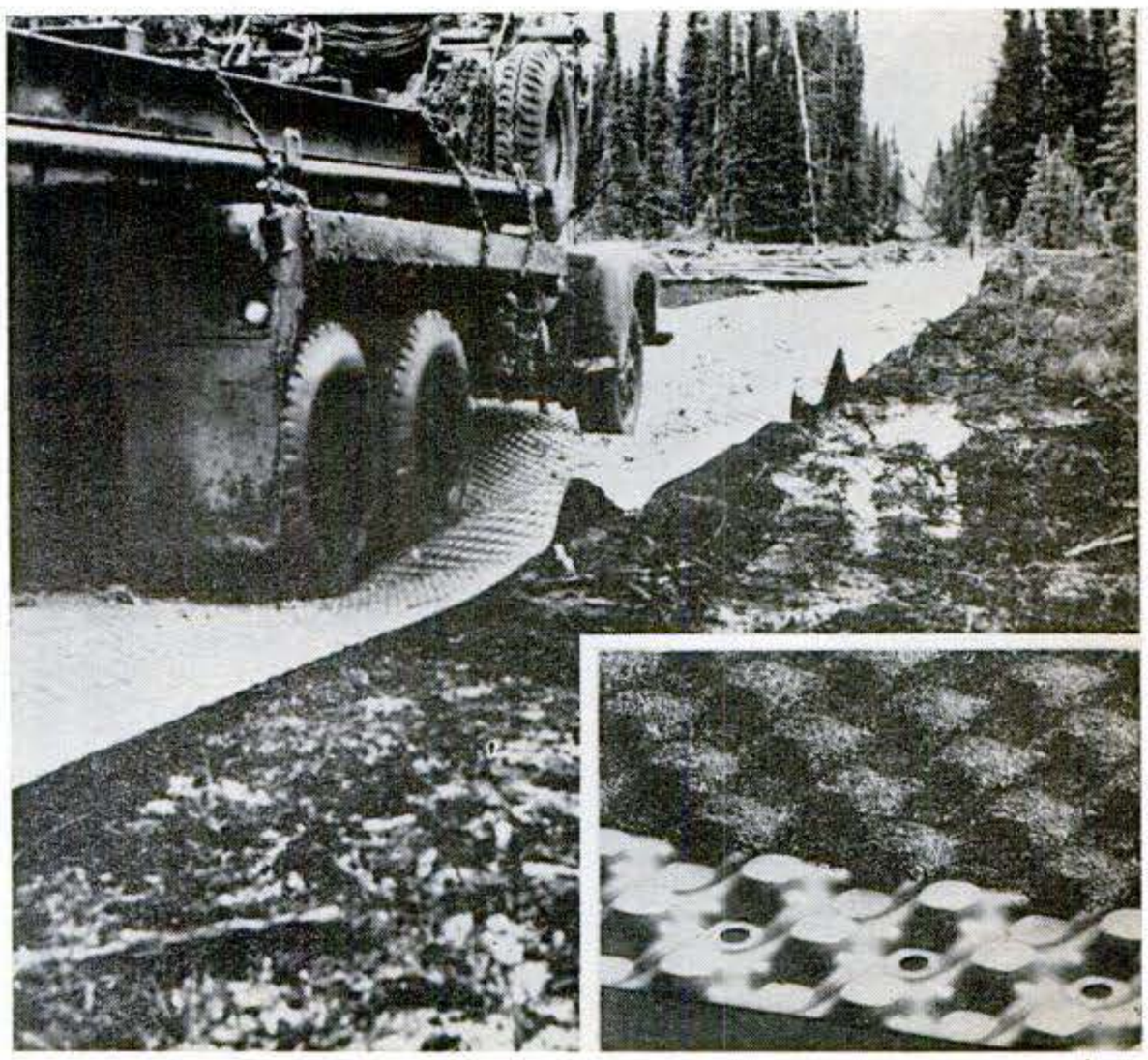


Glow bed

What floats on Plexiglas runners and gives off a cool blue light? Glo Bed II, of course. The light comes from two tubes beneath the mattress and foundation. Price is cool, too—$1,200 without mattress. From Simmons Co., 280 Park Ave., New York, N.Y. 10017.

Instant road

When you need a road in a hurry, Mo-Mat's the answer. Just unroll it and drive. Developed by PPG to keep heavy equipment moving through mud, sand, and snow, the lightweight fiberglass laminate is skid resistant. And it can be rerolled for re-use.



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What's New

For heat lovers: a portable sauna suit

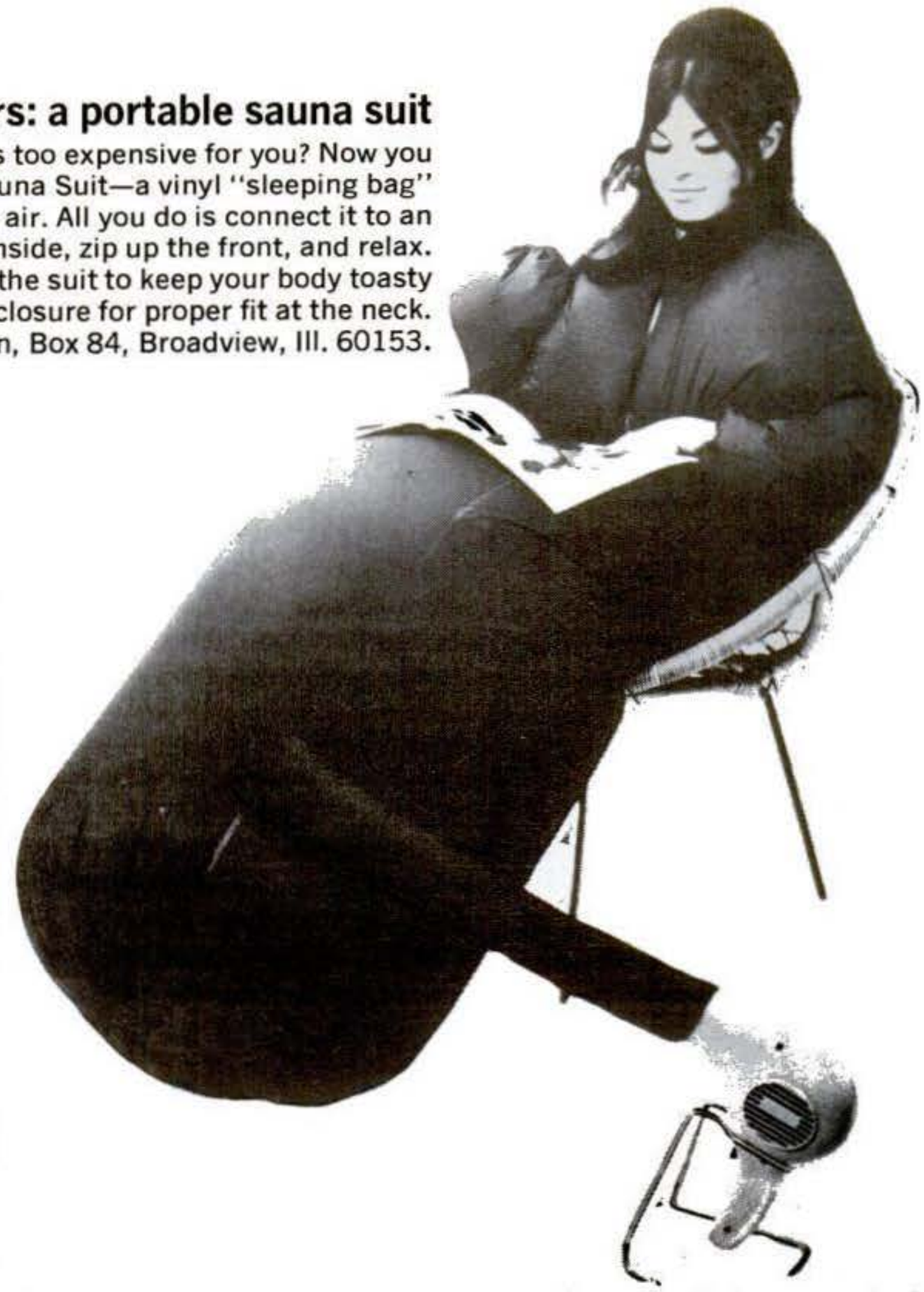
Those fancy sauna rooms too expensive for you? Now you can get instant heat with the Sauna Suit—a vinyl "sleeping bag" full of warm, dry air. All you do is connect it to an ordinary hair dryer, slip inside, zip up the front, and relax. Warm air then inflates the suit to keep your body toasty warm. The suit has a velcro closure for proper fit at the neck. It's $34.95 from Spacetron, Box 84, Broadview, Ill. 60153.

Light beer

When you're done with this can of beer, you crush the can and throw it away or burn it. The 8½-inch-long plastic tube holds 8.8 ounces of suds. A paper sleeve keeps it rigid during pouring and upright on a table. Imperial Chemical Industries makes it in Britain.

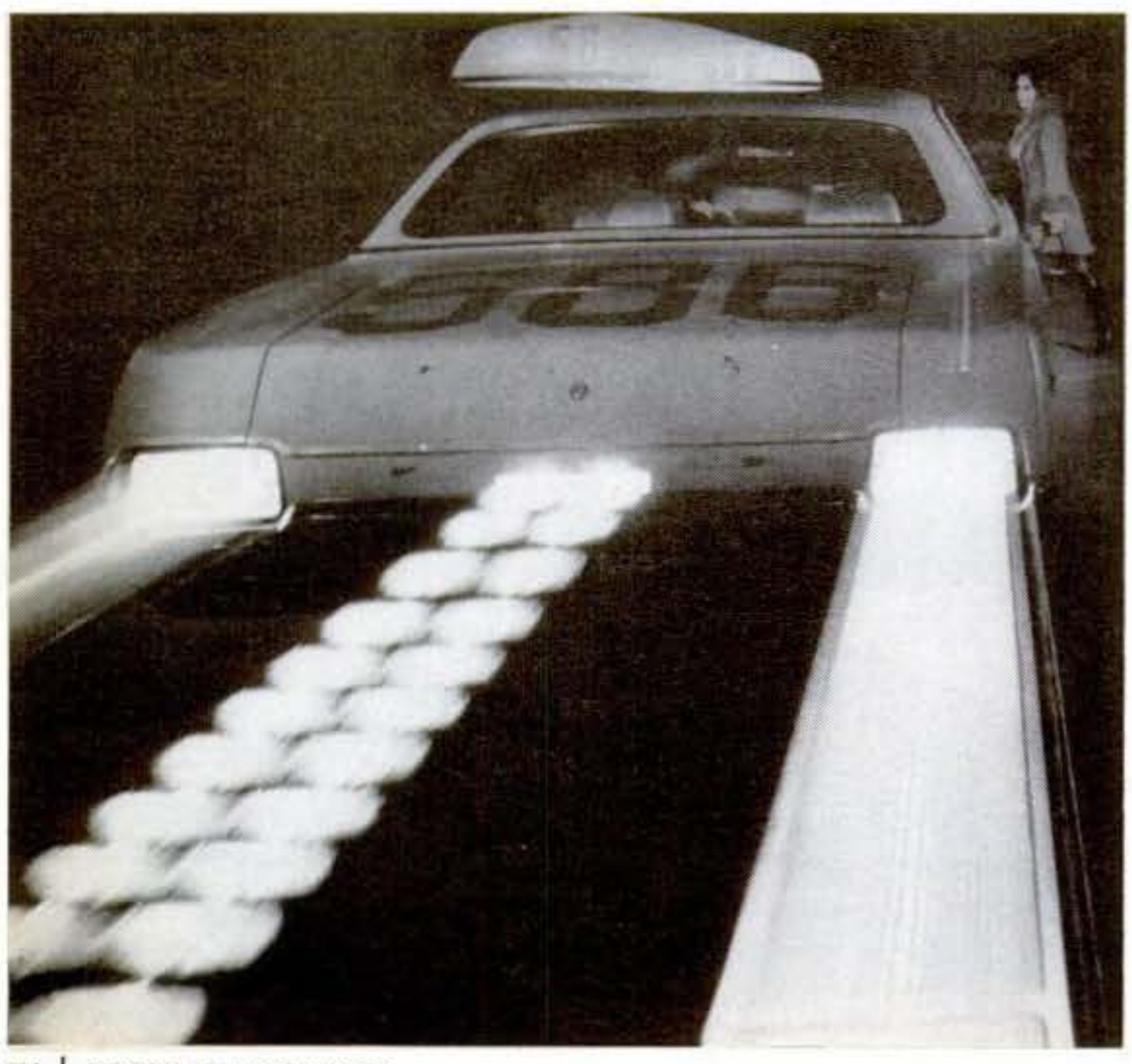
Stairway dolly

Ever try to carry a heavy load up stairs with a hand truck? This German stair dolly ends the bumping and struggling. The device carries three rotating wheels on each side. When you pull the dolly, each wheel uses a successive step. Fred Frieden, 7888 Rheinfelden, Baden, West Germany.



Mushroom furniture

Now you can put a toadstool in your living room: An accent chair with a polyurethane-foam cushion made by a speedy new cold-cure molding process. Mushrooms range from 12 to 36 inches across, sell for $19 to $40. Table has foam edge. Glomar Ind., 637 Stewart Ave., Garden City, N.Y. 11530.



Brake pulse

The harder the driver hits the brakes, the faster and brighter the light pulses from an amber Cyberlite in the center rear of this car. The deceleration warning is being tested by San Francisco Yellow Cabs, under permit from the California Highway Patrol.

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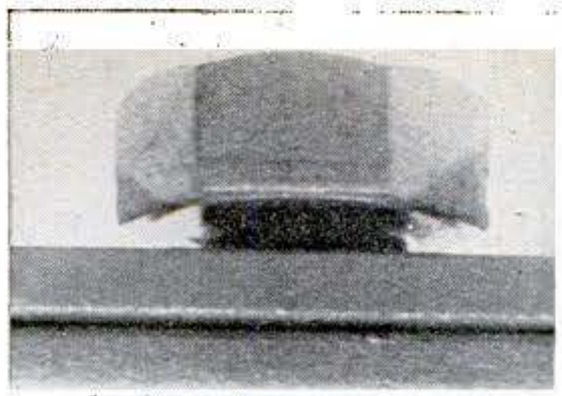
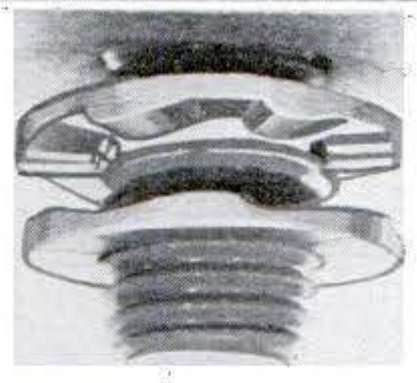
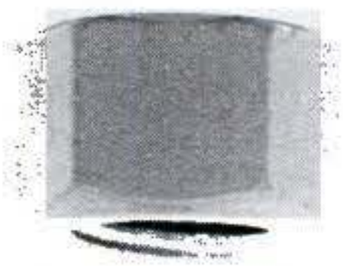
What's New IN TOOLS

Hard driver

Tough screw to turn? A swing-out arm on this rachet screwdriver lets you multiply torque enough to make almost any screw give up. With three interchangeable bits, it's $7.85, plus $1.15 postage. Three Phillips bits add $2.50 to the price. Brookstone Co., Peterborough, N.H. 03458.

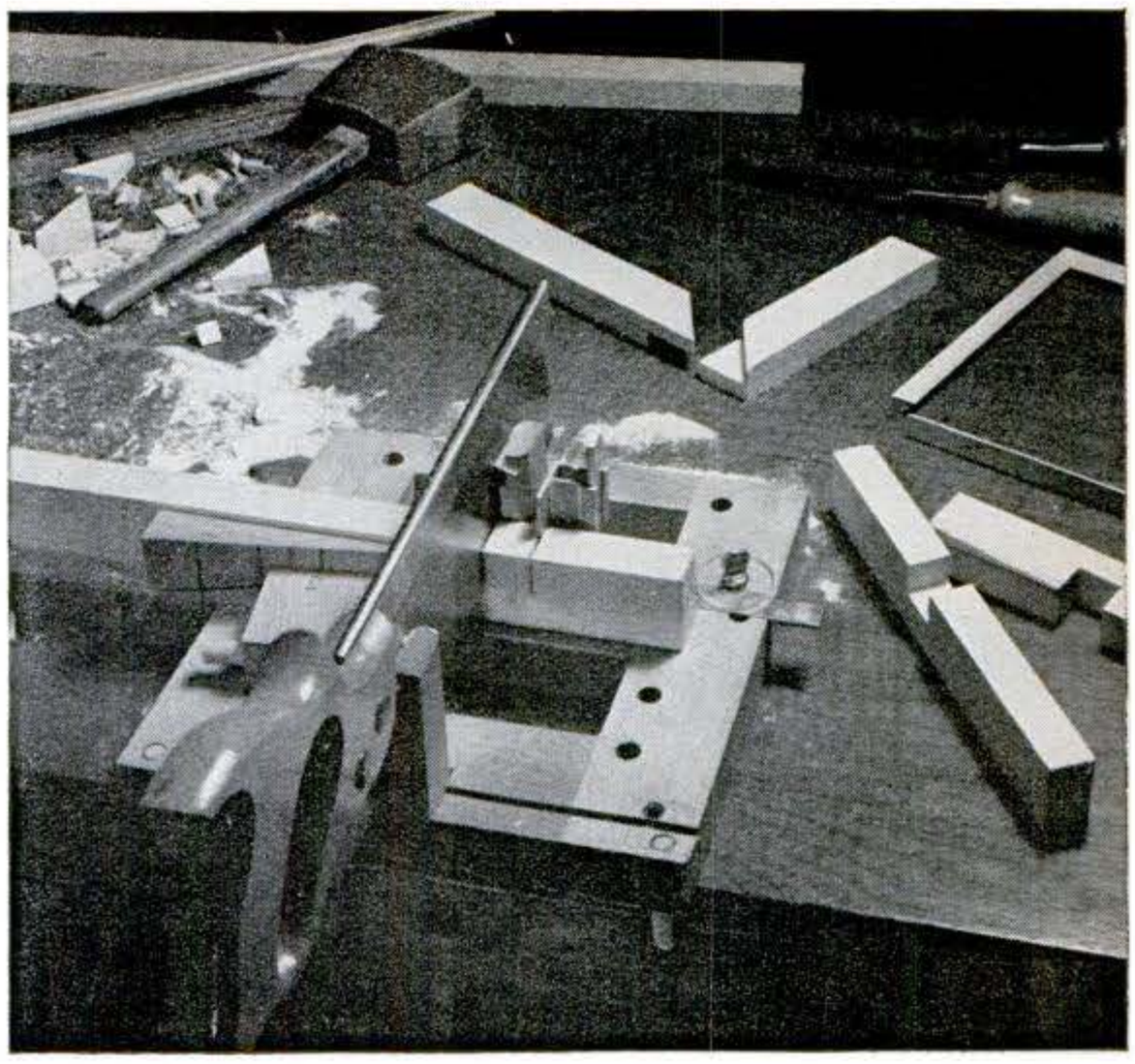






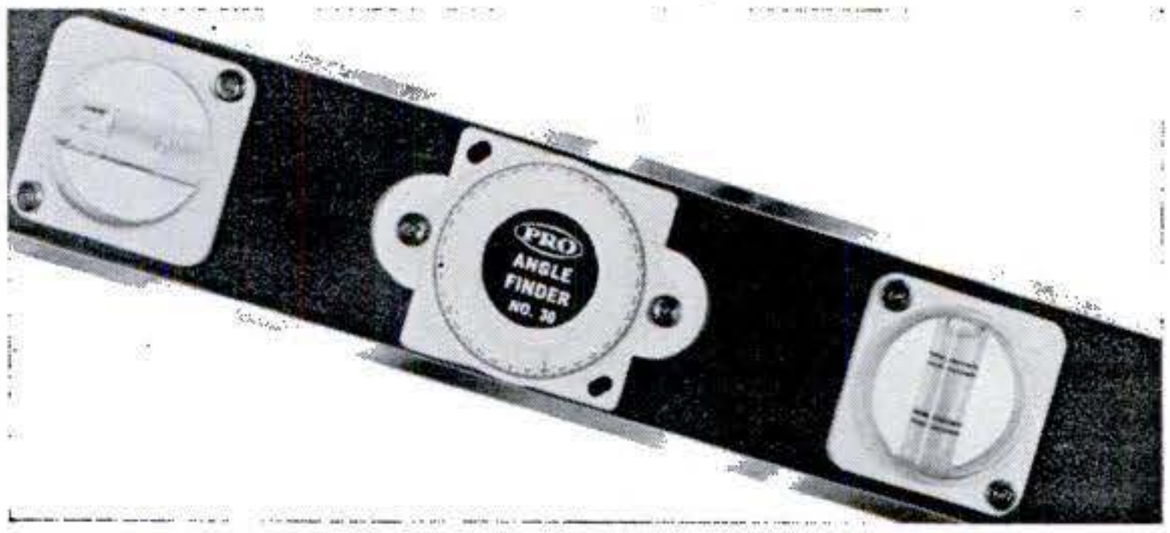
Tough-grip washer

No rattles, no loose nuts, if you insert a two-piece Loc-Kit assembly on a bolt. When a bolt elongates with vibration, the washers rotate on inclined planes to take up the gap. When the bolt contracts, the washers turn the other way. Loc-Kits are made by Flushing Enterprises, Flushing, Ohio.



A simple saw jig for accurate joints

Quarter-degree accuracy in miter joints, repeatable every time, is claimed for this English sawing jig. The work is located and clamped by a square pin, block, and wedge, positioned in holes in the baseboard according to the required angle. Saw guides are faced with nylon springs that hold the blade plumb. The jig can be used for 90-degree butt, double-corner, mortise-and-tenon, dovetail, and other joints. In England, the Jointmaster sells for about $10. It's made by Copydex Ltd., 1 Torquay St., Harrow Rd., London W. 2, England.



Dial reader

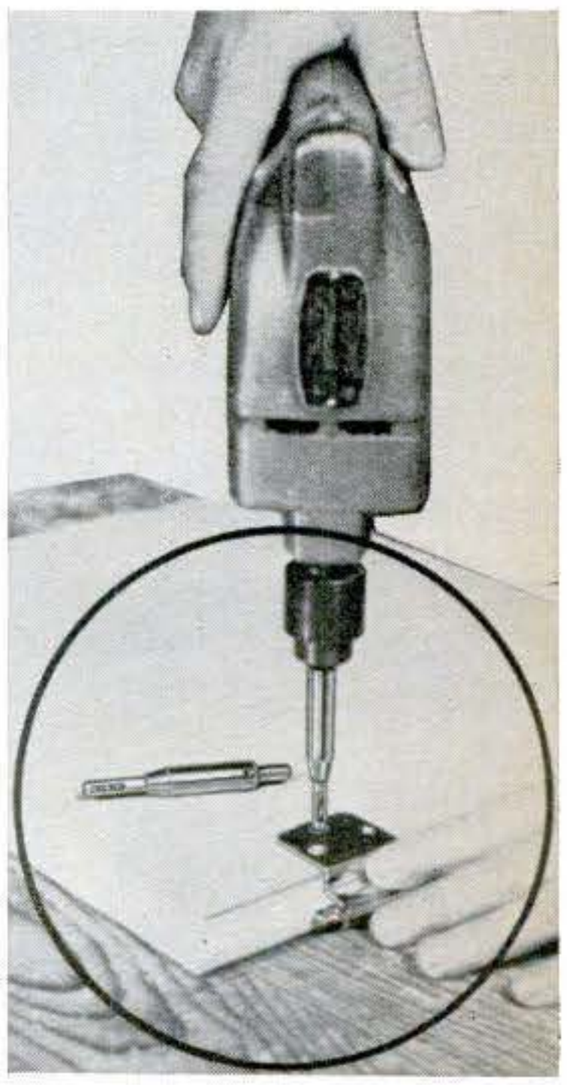
Attach an Angle Finder to your level and you've got a dial instrument that gives accurate angular measurements from zero to 90 degrees in any quadrant. It fits over the handhold—no drilling needed. Retail price: $3. Maker is Pro Products, 812 22nd St., Rockford, Ill. 61108.

Aerosol kit

Lots of home-handyman problems can be solved with this four-areosol kit: silicone lubricant, penetrating oil, moisture repellent, and belt dressing. All four (three 16-ounce cans, one 15) are $5.80 from L. H. Shingle Co., 1300 Walnut St., Camden, N.J. 08103.

Self-centerer

No marking, measuring, or center-punching—the self-centering Vix-Bit drills the right size hole in the right place to the right depth. Secret: a retractable drill guide. Two sizes: for cabinet hinges ($3.99) and butt hinges ($5). Both, $7.95 from H. L. Japs, 126 7th Ave., Hopkins, Minn.



Long-nose locker

Only long-nose locking plier on the market, this new Lever-Wrench can get into the tight spots for quick, no-fumble grabbing, with automatic locking. It's $4.99 from Leverage Tools, Inc., Glenvil, Nebr. 68941.

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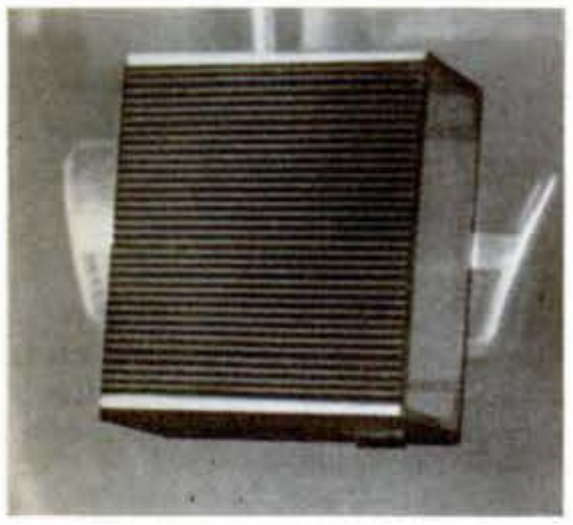
What's New FOR YOUR CAR

Spare-tire carrier

Get a spare tire out in 10 seconds? That's the claim for Hugh's Spare Tire Carrier. It stores under the rear of a pickup for quick access, requires no lifting or going under the truck. $29.95. BMAC Industries, 69 W. Congress St., St. Paul, Minn. 55107.

Ride smoother

Put a shock absorber between cab and bed of your pickup for a smoother ride and less vehicle wear, say the makers of Cab Damper. Reason: It absorbs body torque and twist. They're $25.95 a pair ($35.95 in chrome). Blackstone Mfg. Co., 4630 W. Harrison St., Chicago, Ill. 60644.



Pedal extension

Designed for driver-education programs, the brake-pedal extension at left gives the short guys a break. It's attached with thumbscrews, fits all cars but subcompacts. There's one available for the accelerator, too. $2.95 from Bumpa-Tel, Inc., P.O. Box 611, Cape Girardeau, Mo. 63701.

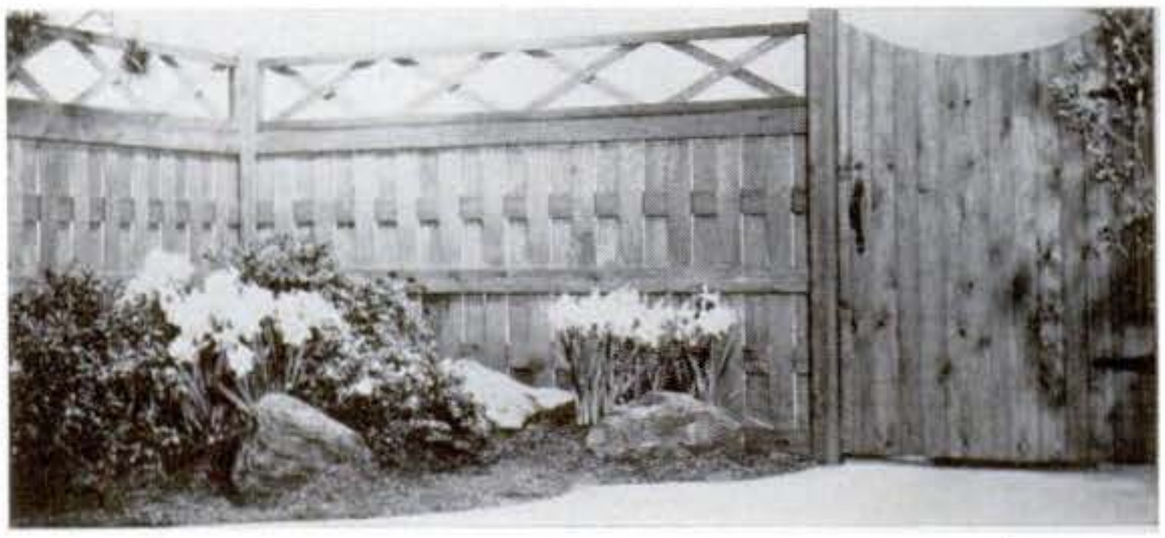
Zip-on tubing

For car buffs who want to neaten their wiring, Zippertubing wraps around the cables and zips closed. No need for disassembly. The tubing can be unzipped again or sealed permanently. $2.95 for a 10-foot roll. Zippertubing Co., 494 S. Riverview Dr., Totowa, N.J. 07512.

What's New IN HOME IMPROVEMENT

Cast-iron classic

Here's a new version of the old classic Franklin wood-burning stove, but this one broils your steak as well as keeps you warm. Franklin fireplace features a three-quart cooking pot and swing-out barbecue grill. It's $225.95 from Preway, Inc., Wisconsin Rapids, Wis. 54494.



Woven fencing

Want privacy plus beauty? New Scotch-Weave woven fencing comes in four-, five-, or six-foot heights, vertical or horizontal weaves. Eight-foot sections come assembled, and there's a matching lattice "topper." Potlatch Forests, Inc., P.O. Box 3591, San Francisco, Calif. 94119.

Slide-out board

You never see that chopping board below until you need it. Made with a "drawer front," the 1½-inch-thick board rolls out on ball bearings. The cabinet is $116. Long-Bell, P.O. Box 8411, Portland, Ore. 97207.

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What's New IN ELECTRONICS

Door decor

Aztec's the name of the interesting molding pattern on the door above. The plastic molding can be painted to match your door, and it won't warp, crack, shrink, or swell. Pease Co., Ever/Strait Div., 7100 Dixie Hwy., Fairfield, Conn. 45014.

Musical calculator

Listen to music while you do calculations? Right. Crown Radio's new unit features a battery-operated clock, a seven-transistor AM/FM radio, and a 10-key, eight-digit calculator. It's $220. Crown Radio Corp., 228 E. Harris Ave., San Francisco, Calif. 94080.

Component hi-fi

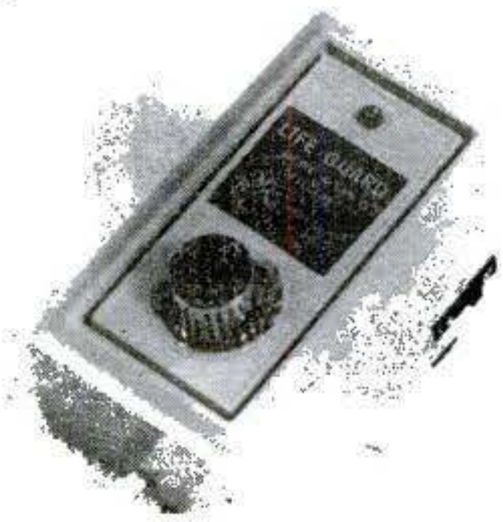
Now Sylvania has hi-fi component systems, too. This one features their new 50-watt (RMS) AM/FM receiver, with high FM sensitivity. The CR2742W has full controls for phono, tape, and auxiliary inputs. Jack panels accommodate a four-channel decoder. With walnut cabinet: $200.

Stereo tester

For the hi-fi buff, here's an oscilloscope that measures the "heartbeat" of your stereo system. A five-position selector checks voltage measurement, left- and right-channel audio signal, tuner performance, and antenna reception. The Kenwood Audio Lab Scope is $225.

Hand compactor

Those motorized compactors too expensive? Put a Trashpactor Impactor on your garbage can. Just put in the liner, fill 'er up, slip on the lid, and tamp with the plunger. Price without the can: $9.95. Akens-Adornetto Industries, Inc., Route 9, West Pike, Zanesville, Ohio 43701.

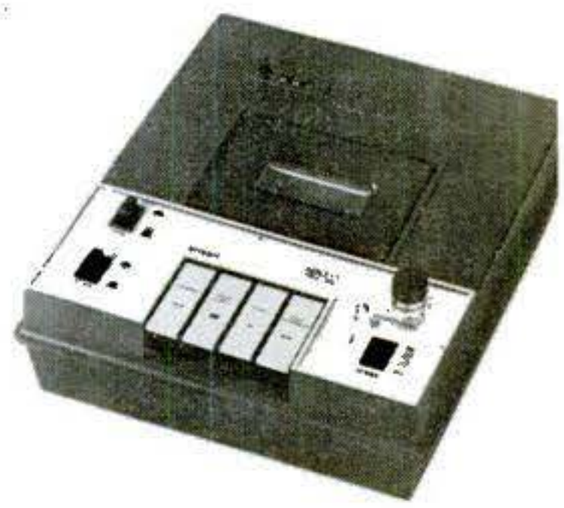


Smoke detector

This electronic sniffer senses carbon monoxide, butane, propane, and other air contaminates and converts them into an electrical signal. A buzzer alerts you of danger. The Life Guard Selector plugs into any AC outlet, sells for about $40. MRL, 7227 Lee Hwy., Falls Church, Va. 22046.

Music maker

Here's a neat package: AM/FM radio; cassette recorder with built-in mike, automatic record-level circuit, automatic end-of-tape stop; and a rechargeable battery. The 7¾-pound Wollensak model 4515 is $100.



Dolbyized player

Want top sound from prerecorded cassettes? This top-performance playback deck has circuitry for cassettes recorded with the Dolby noise-reduction system. Advent's 202 is $130. Another model has built-in headphone amplifier and jack. Advent Corp., 195 Albany St., Cambridge, Mass. 02134.

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What's New
IN BOATING

Floating reel

Square yo-yo? No—it's a multipurpose floating reel for ski or anchor rope. Made of polyfoam, it's a boat fender or anchor marker, too. Type I (for 125 feet of ¼-inch rope): $6.95. Type II (for ⅜-inch rope): $7.95. UERM Marine Products, 5846 East Ave., Livermore, Calif. 94550.

Lightweight canoe

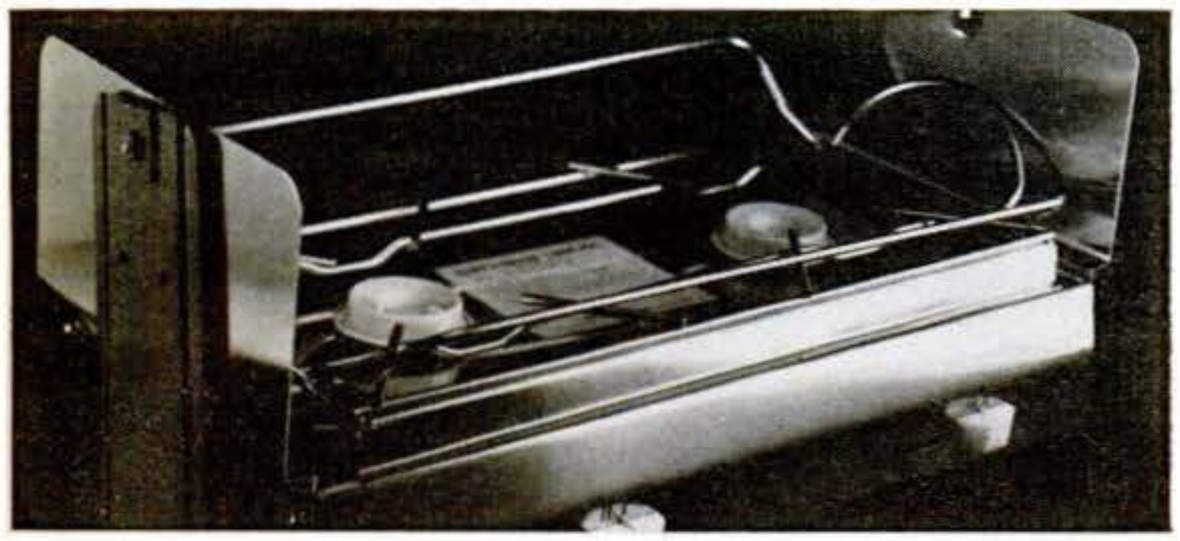
For the backpacker or lone sportsman, here's an eight-foot canoe. Weighing in at about 20 pounds, the Papoose is made of aircraft aluminum and lined with plastic foam. Price is $185. It's made by Sportspal, Inc., Emlenton, Pa. 16373.

Roomy tri-hull

Safety-glass walk-through windshield, built-in step for easy shoreside boarding, carpeting underfoot, side trays for storage, and full foam flotation—these are some of the features of Fiberform's new Beachcomber. The 18½-foot-tri-hull weighs 1,510 pounds without engine.

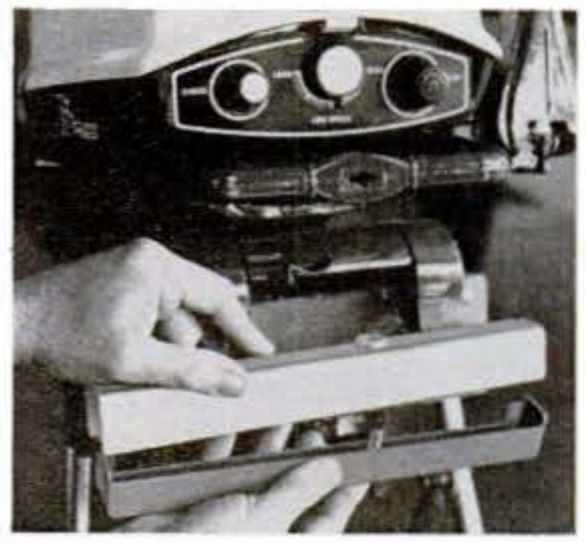
No-hands motor

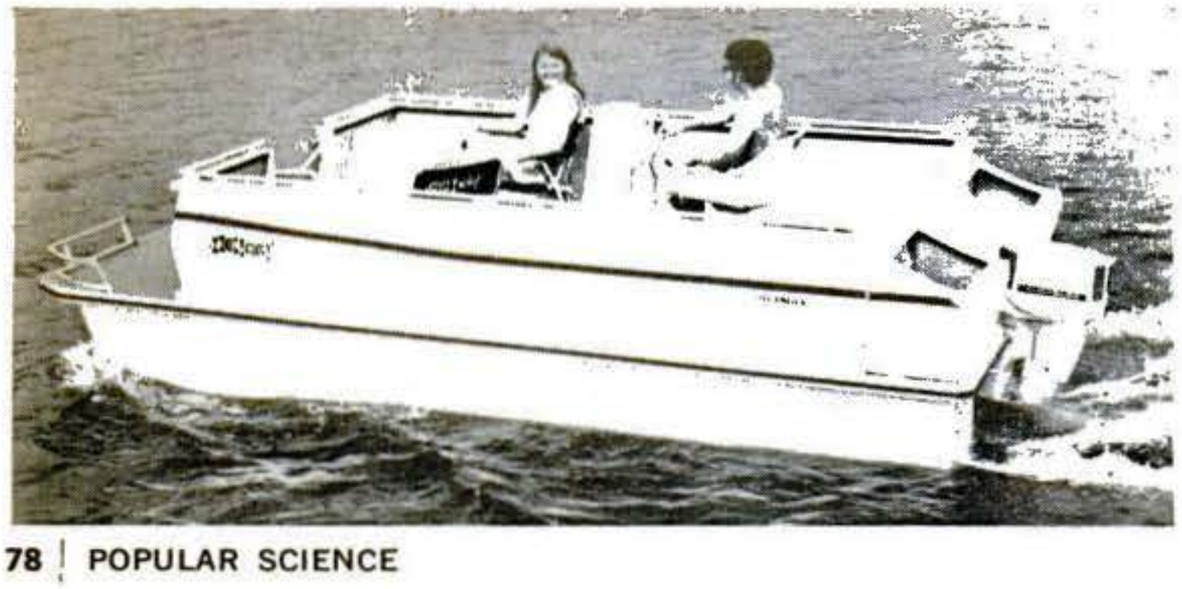
When your fishing boat's powered by the Ranger II Remote electric motor, you can keep both hands on the fishing rod. To turn, you press the foot pedal: toe for right, heel for left. It's $189.50. Electra Pal, 1400 E. Lafayette St., Bloomington, Ill. 61701.



Quick-light stove

There's no priming or pumping with this stainless-steel alcohol boat stove—and, says the maker, it lights instantly and won't flare up. Fuel tank holds a quart. Price: $84 from Bass Products, Box 901, Marblehead, Mass. 01945.





Fun box

It's like taking your garden patio out on the water. The Islander 16 offers vinyl carpeting, safety and swim rails, and eight by 16 feet of fun boat sitting on two fiberglass pontoons. It's $1,295 from Holiday, Box 67, Sturgis, Mich. 49091.

Outboard lock

If chain and padlock won't foil outboard thieves, maybe the Sher-Lock will. It fits over the turndown handles of the motor mount, locking them inside. A cylinder lock, turning on a bolt in the Sher-Lock's bottom plate, secures it. It's $8.95. Maker: The Brandon Co., Rte. 1025, St. Paul, Minn. 55110.

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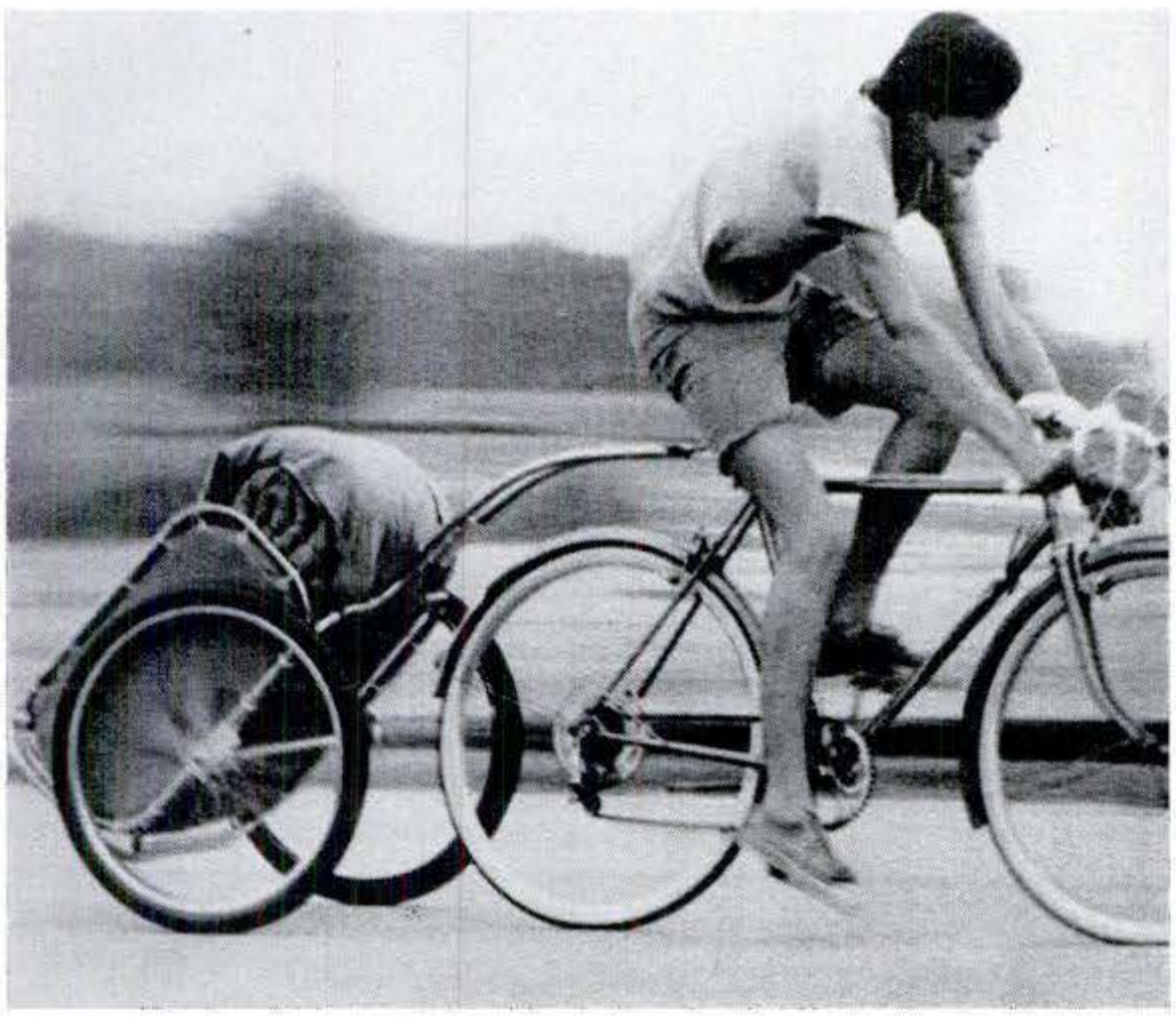
What's New IN OUTDOOR RECREATION

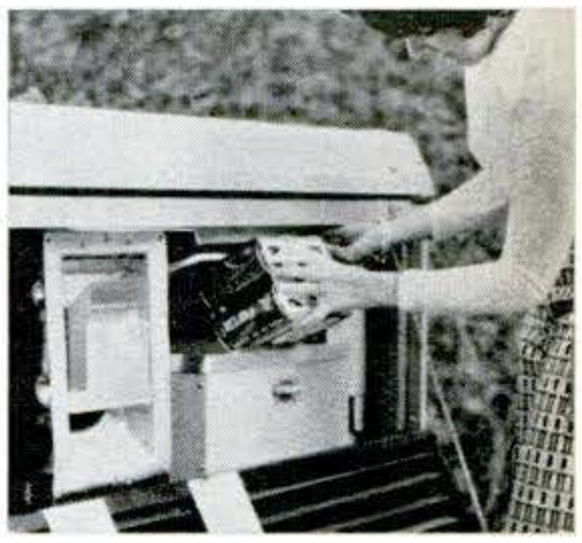
For Beetle owners: a rooftop home

Go camping in your VW and sleep on the roof? You can if you've got a Bug House—a four-by-eight foot rooftop deck fitted with a polyurethane-coated nylon tent. Fold the fiberglass deck and it becomes a storage cavity for the tent. Leave it on the roof and you've got a luggage rack. The tent has windows that open and close for privacy, and double-zippered openings at each end. An anodized aluminum ladder lets you climb up to the tent once it's set up. The Bug House weighs 75 pounds and costs $495. From Weslen, Inc., Torrance, Calif.



Quick-lunch kitchen

Ever wish you had a camper that would let you pack the ice chest, fill the water tank, and stop to have lunch—without having to unlatch the top? Wish no longer. A rear panel on Nimrod campers gives access to the kitchen. Nimrod, 500 Ford Blvd., Hamilton, Ohio 45011.



Bicycle trailer

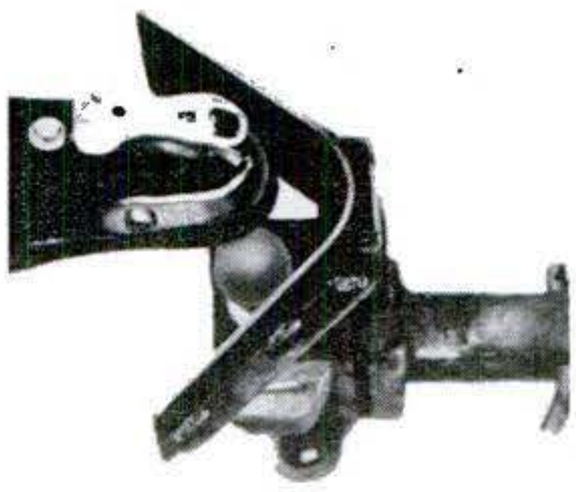
For bike campers, here's a backpack on wheels. It's the Bugger, fine for shopping and golfing, too. A unique torsion control arm assures no-weave tracking and perfect handling, says the maker. It's $39.95. Cannondale Corp., 35 Pulaski St., Stamford, Conn. 06902.

Snagless reel

Many a skinned knuckle, tangled line, and broken leader are eliminated by this reel, claims the maker. It works on the planetary-gear principle, but only the knob rotates—on its own axis instead of whirling around the spool. $62.50. Val-Craft, 67 N. Worcester St., Chartley, Mass. 02712.

Alarm lock

Lock and alarm are combined in the Howler. If a thief breaks its locking cable, it'll howl for an hour unless it's turned off with your key. The ABS-plastic alarm unit will, it's claimed, withstand even hammer blows. It's $16.95 from Sunrise House, Blake Bldg., Gilroy, Calif. 95020.



Hitch guide

Install this V-shaped guide over your car's hitch bar and you'll have a perfect line-up of your car and trailer every time for easy coupling. The guard is removed for traveling. Price: $19.95. MFG Co., Box 675, Ashtabula, Ohio 44004.

Direction finder

Lost? Boatmen or hunters can use this simple radio direction finder to find their exact position day or night. The two-band H.E.L.P. Mark 2 R/CDF comes with ferrite antenna, compass, and earphone. $39.95 from Davis Instruments, 857 Thornton St., San Leandro, Calif. 94577.

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Nearly-completed dome is studded inside with the screw hooks used in load-testing program. Dome handled 60 pounds per square foot.

Bucky Fuller's Hexa-Pent:

PS takes the guesswork out of dome building with a dome designed, engineered, tested by the best in the business

Have you been thinking of building a dome, but waiting for the right design to come along? Wait no longer. We think we've got the best design on the market.

Our plans? They're right from Buckminster Fuller—the *inventor* of the geodesic dome. And they've been computer checked by leading experts on dome engineering.

If you saw last month's centennial issue of POPULAR SCIENCE, you saw the dome as an architect's model. This month, take a look at the real thing—the first dome built from our new Hexa-Pent plans. We put this one up with a definite purpose in mind—to see what it can take.

On April 18, Simpson Gumpertz & Heger—the consulting engineers who handled the U.S. geodesic pavilion at Montreal's Expo—hung a maze of 60 55-gallon drums from hooks in the Hexa-Pent's ceiling.

Then they pumped them full of water—3,000 gallons of it, for a total weight of 25,000 pounds. The resulting load of over 60 pounds per square foot is more than the dome is likely to encounter, since it's 1½ times the design snow load for Boston, where our dome was erected.

The test verified S. G. & H's engineering study. This study—supplied with every set of plans purchased—should help in getting a permit to build from your local building inspector. And with that permit in hand you're set to begin the building process outlined in the photographs you see on these two pages. PS

How to order plans for building the dome

For one set of plans for building the Fuller & Sadao 24-foot dome, send $15 (check or money order) to Popular Science Plans Division, 355 Lexington Ave., New York, N.Y. 10017. Need two sets? Send $20. Allow three weeks for delivery.

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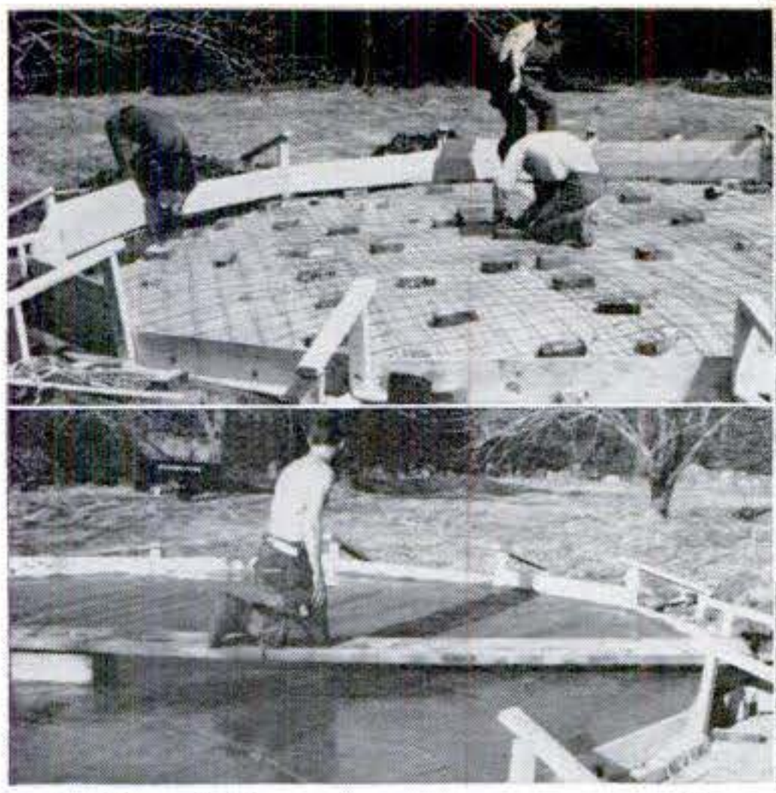
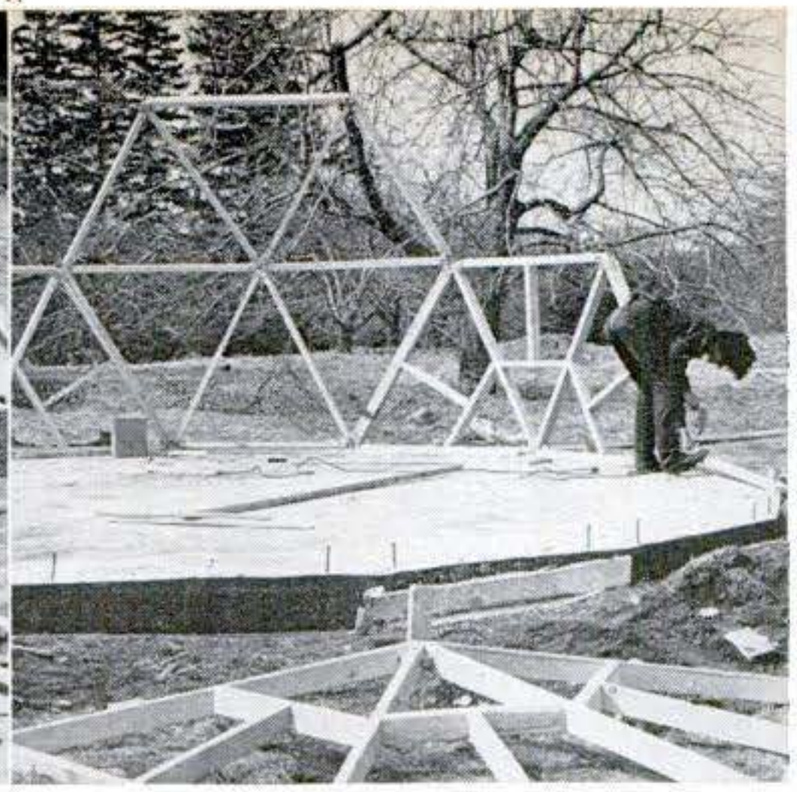


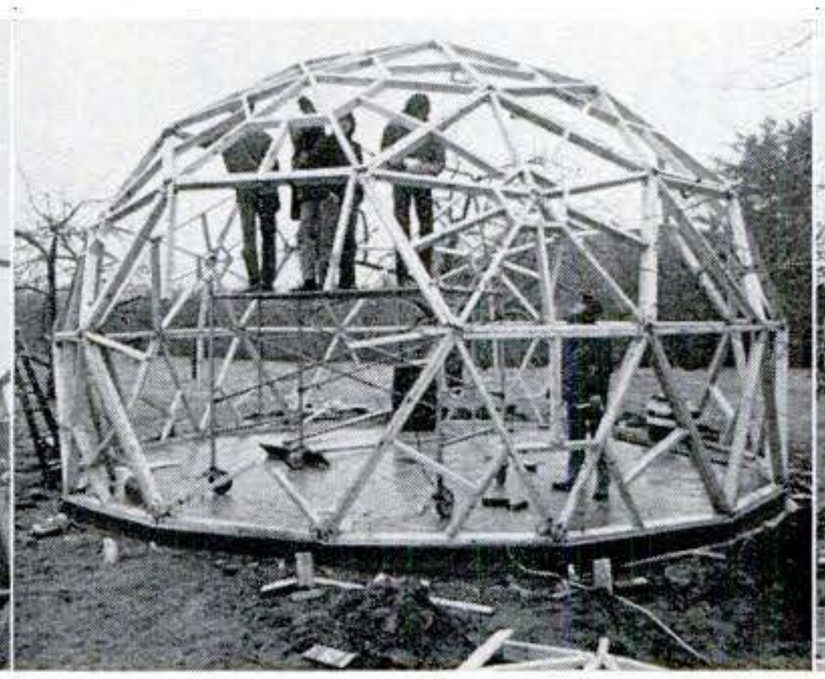
Slab foundation of concrete comes first. Forms are laid out carefully by measuring with wire from a stake in center of slab. Sheet plastic on ground forms vapor barrier. Wire reinforcing supported on bricks goes over the plastic, then comes the concrete. Prototype, built by Dome-Iciles of Boston, took about 10 yards of concrete. You can mix your own but ready-mix is simpler.



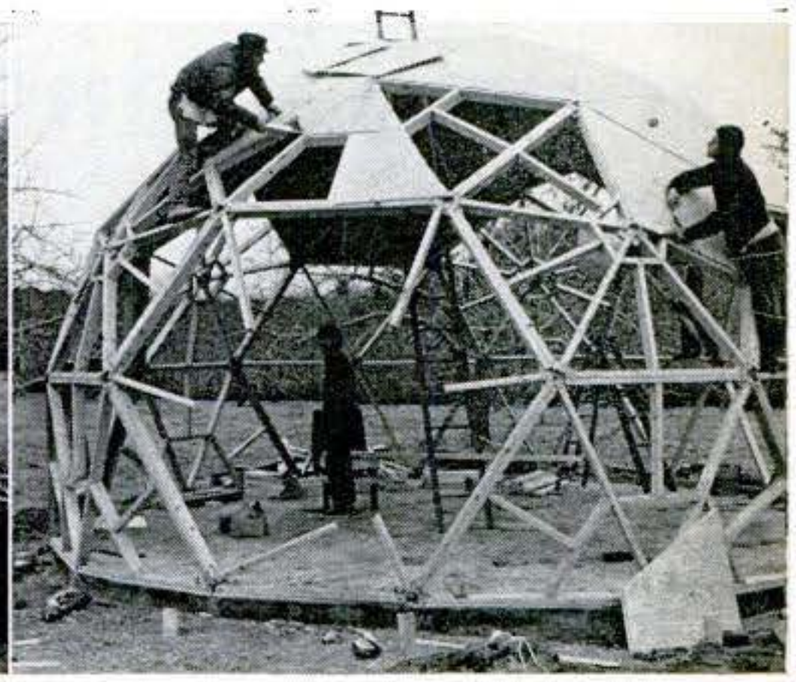
Lower course of dome components—half hexes and pents—fasten to the slab with anchor bolts. Hexagon here will receive supplementary strutting for windows later.

Five pentagons of second course can be lifted into place by two men working inside dome. When units are in place, heavy plated bolts fasten them to each other.

A scaffold is a big help from here on out. Note how C clamps are being used to hold this hex unit in place temporarily while bolts are inserted and snugged up.

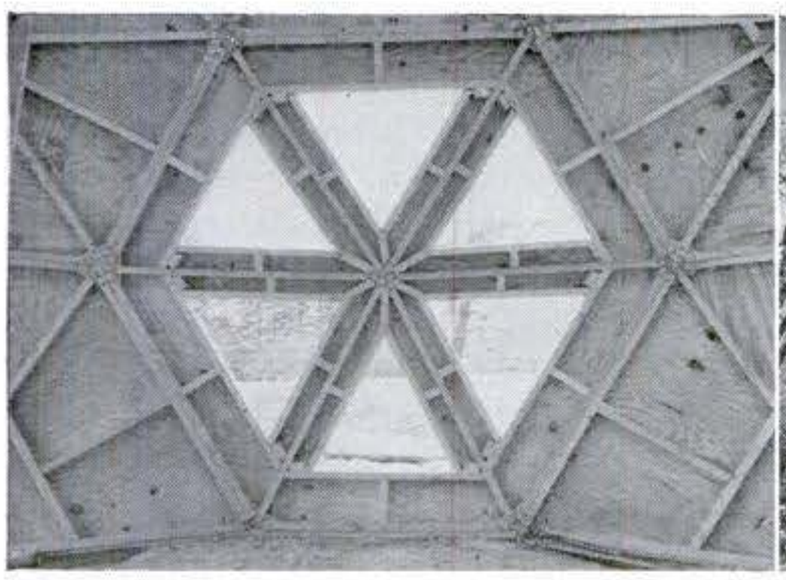


Spherical shape of the dome appears as more hex units are added. We erected the framing, then added the skin for demonstration. Units should be skinned on ground.



Plywood skin goes on with panel adhesive and ring-shanked nails. Skinning is critical step, since the dome owes a great deal of its strength to the plywood covering.

Domehome You Can Build



Window framing in the five lower hexes is intricate. Unless you do all your work up to this point accurately you may have to custom-fit many of these parts.

Rosette windows go in four of the five hexagonal units in dome's lower course. Extra windows and ventilating louver are incorporated in pentagon at dome's apex.

Skinned dome minus door panel awaits installation of drums (foreground) for weight test. Finished dome will receive the new Semprall base and finish coat system.

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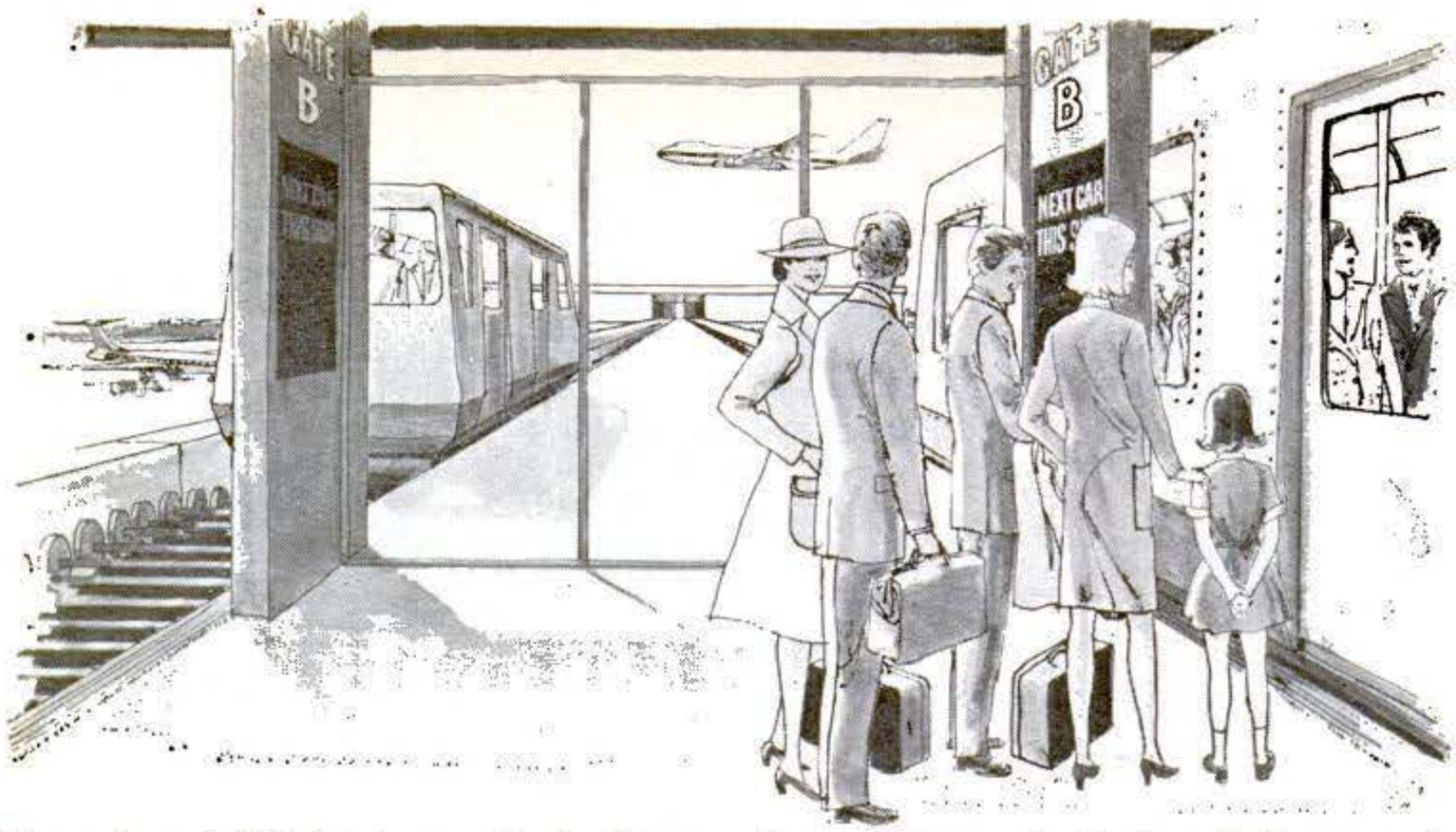


Waves from inflated tubes push shuttle cars along stationary tracks in artist's concept.

Surfboard Conveyor: New Wave in Ground Transportation?

Here's how a stationary track may transport you on waves of air

By DAVID SCOTT / *PS European Editor*

You step into a ground-conveyor car; the door clicks shut. There's a faint whoosh of air. Beneath your feet, the floor suddenly rises and your car tilts forward slightly. You're zipping toward a plane or train departure gate on a wave of air!

That's just one possible use for a far-out stationary-track pneumatic conveyor devised at Britain's Cranfield Institute of Technology. The lab models I saw top endless-belt systems on several counts. They can change speed at different sections along their length, turn corners, and climb steep gradients without backsliding. Practical versions could move people, cars, baggage, or factory products—using very little power.

How they work. Wheeled models ride on a slatted mat laid over thin-walled flexible tubes, flattening and sealing them. When low-pressure air is piped through the tubes, they inflate behind the back wheels, lifting the mat to the height of their diameter.

Slats partially wrap around the wheels, thrusting against the axles and rolling the cart forward. This movement is like surfboarding, where up-and-down and not forward motion of individual water particles provides the drive.

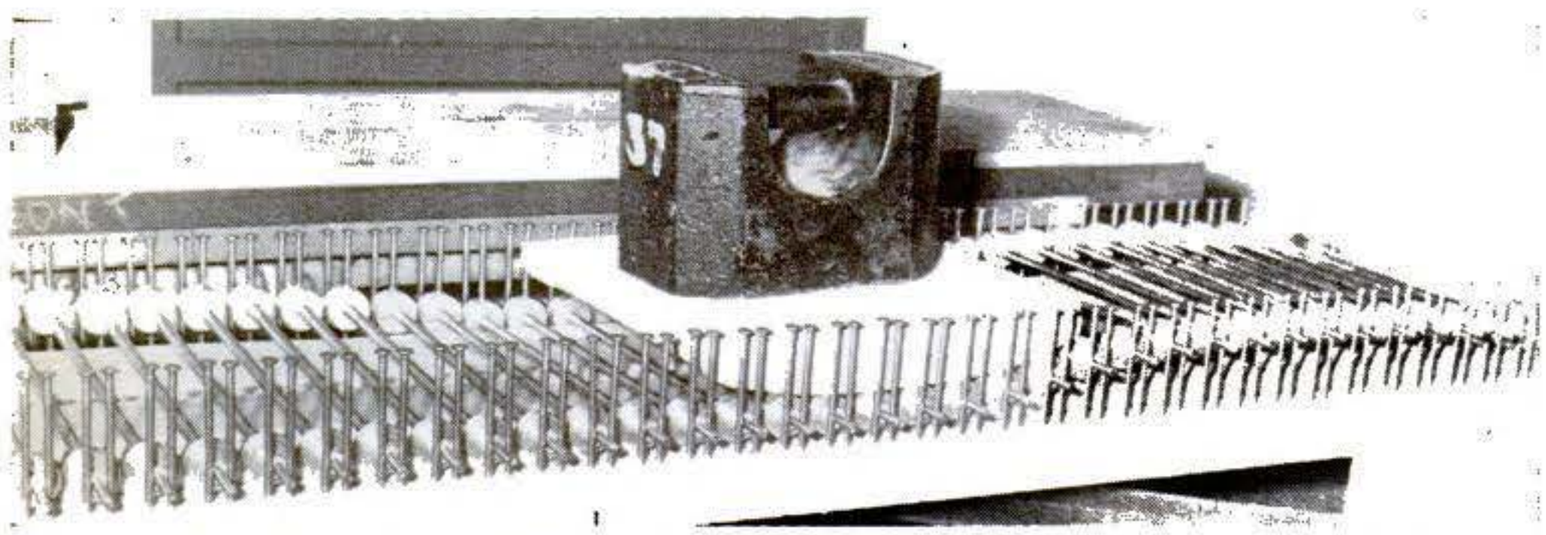
With a second cart on the track, the lead one is driven at the same speed by air trapped in the tubes between the two. This intervening air cushion automatically keeps the two vehicles spaced safely apart, so tail-end collisions are impossible. On a downgrade the rear cart is braked by the intervening cushion again.

Changing speed. On curves, the slats are tapered, and pallets are steered by castered front wheels. Speed can be increased along any section by using smaller-diameter tubes there. Since air flow is constant, the velocity is greater through a restricted area. Larger tubes reduce the speed but increase thrust—like down-shifts in your car.

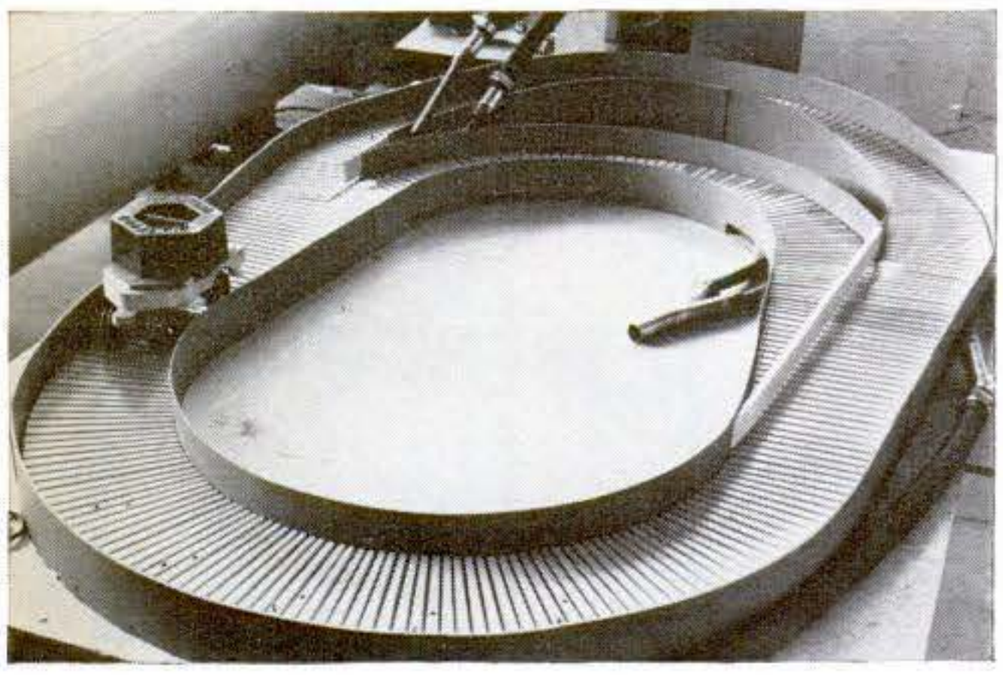
Thrust determines climbing ability, and bigger tubes provide greater wrap around the wheels. With oval tubes having a high width-to-height ratio, gradients of 25 percent should be possible with the system.

Efficiency is high because frictional losses, mainly from tube and mat flexing, are very small. Low-pressure air (around one psi) from a compressor

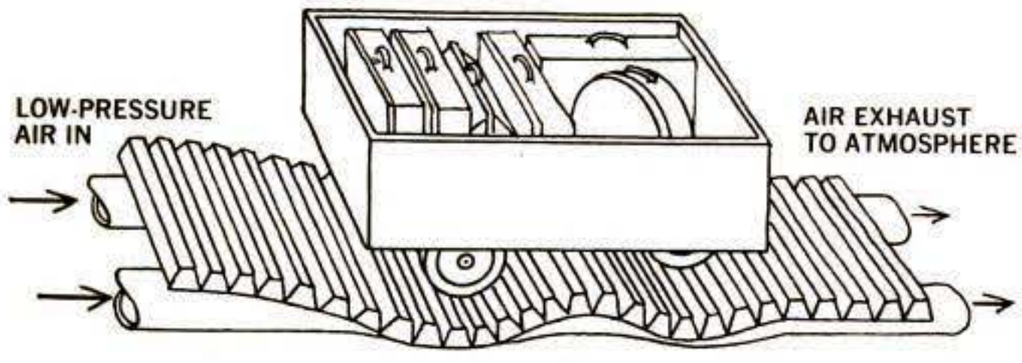
[Continued on page 135]



Wave action advances sled-like platform over lab conveyor. Rollers retained by vertical slots rise in a wave behind sled when axles are lifted by inflated tube below mat.



Wheeled model turns corners, climbs inclines, changes speed and tracks. High- and low-pressure supplies feed two U-shaped tubes.



Air-tube diameter determines forward thrust by varying amount of wrap around the rear wheels of the cart.

A puff into flat tubing by John Spillman propels steel cylinders. Trapped air drives front cylinder, maintains spacing.

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Honda's Dual-Purpose Single

Quiet on the Street, a Tiger on the Trail

You can ride this machine right out of the showroom, down the road, into the woods

By **JIM DAVIS** / *PS West Coast Editor*

Trail riding's fun. So is street riding. But how many of us can afford a trail bike and a street machine at the same time? That's where the latest bike I've tested comes in—Honda's XL-250 Motosport. It's made for both street and trail.

Displacing 248cc, the four-stroke engine is the largest single-cylinder power plant Honda has ever used in a motorcycle. It has a four-valve head—that's right, four. Why? In a conventional two-valve head, good top-speed performance requires the intake valve to open early and close late to permit enough fuel-air mixture to enter the cylinder. At the lower revs needed in a dirt-bike engine, early opening and late closing permit leakage of the mixture and lower cylinder pressure. The dual intake valves, because of their lighter weight per valve and extra total area, can be lifted later and faster, providing excellent sealing at low rpm and adequate breathing at high speed.

The engine produces a flat torque curve and provides plenty of pulling power at all speeds. A five-speed transmission with ratios well matched to the engine further enhances the bike's off-roadability. Riding up steep hills was a pleasure because there was always plenty of power on tap.

Noise? The high-mounted spark-arrester/muffler does an excellent job, making the Motosport one of the quietest off-road machines around. The ride is comfortable and the stock suspension is more than adequate for casual trail riding and comfortable highway use. A stiffer setup's in order for a steady diet of really rough terrain.

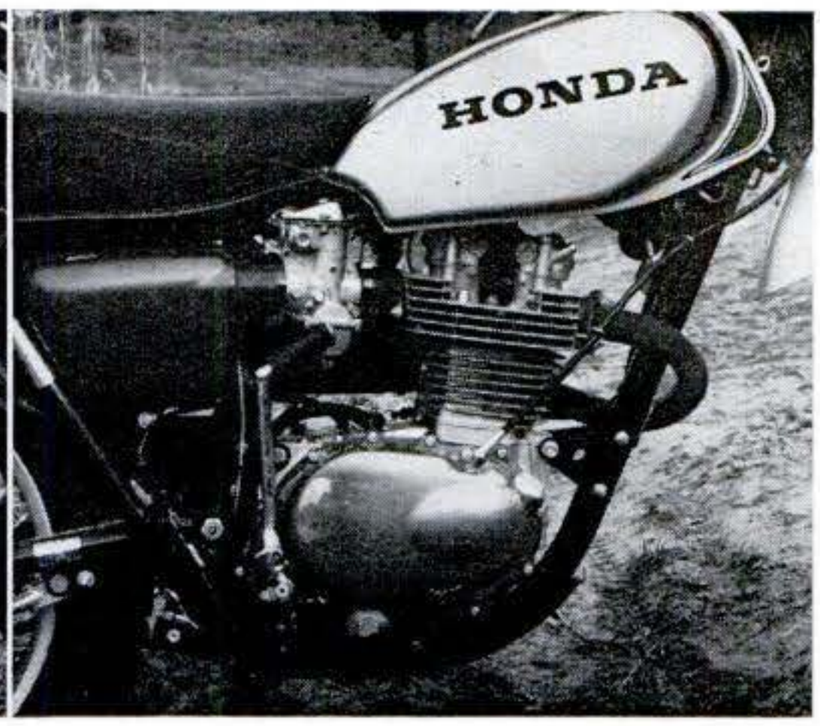
Overall, I found the Honda an excellent machine. If you're on the market for a dual-purpose motorcycle, you've got to consider this one. PS

Very quiet when running, Motosport's four-cycle engine produces the high, flat torque curve necessary for off-road riding.

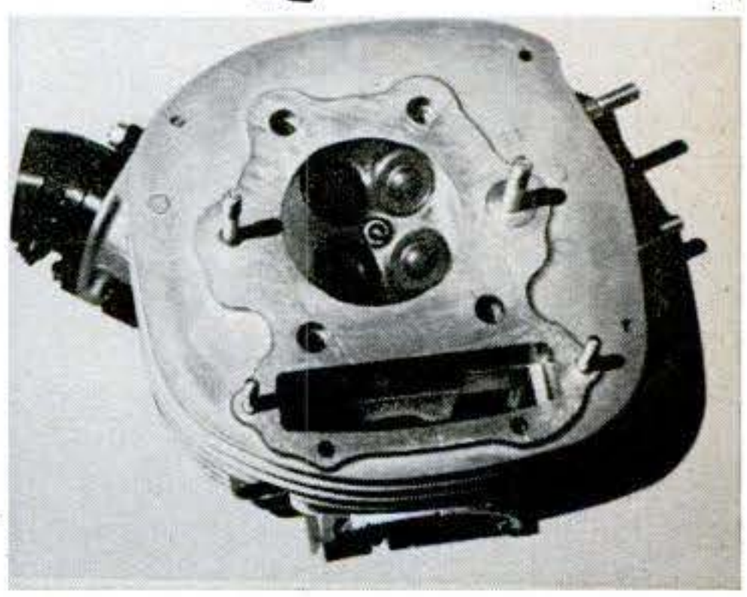
Motosport XL-250 specifications

Engine	Single-cylinder OHC four-stroke
Bore and stroke	74x57.8 mm
Displacement	248cc
Seat height	32.3 inches
Wheelbase	54.5 inches
Ground clearance	7.5 inches
Weight, dry	278 pounds
Brakes, front and rear	single leading shoe, internal expanding
Transmission	5-speed, constant mesh
Clutch	wet, multidisk
Gear ratios, 1st	2.352:1
2nd	1.666:1
3rd	1.280:1
4th	1.0:1
5th	.806:1
Top speed	approximately 80 mph
Fuel-tank capacity	2.1 gallons
Cost	$850

Lightweight flexible fenders resist breakage. The bike's front fork angle, wheelbase, and ground clearance are adjustable.



To reduce engine weight, Honda built the XL-250 power plant with magnesium sideplates. The engine weighs 84 pounds, dry.



Cylinder head has four valves for more efficient breathing, centrally located spark plug for better flame distribution.

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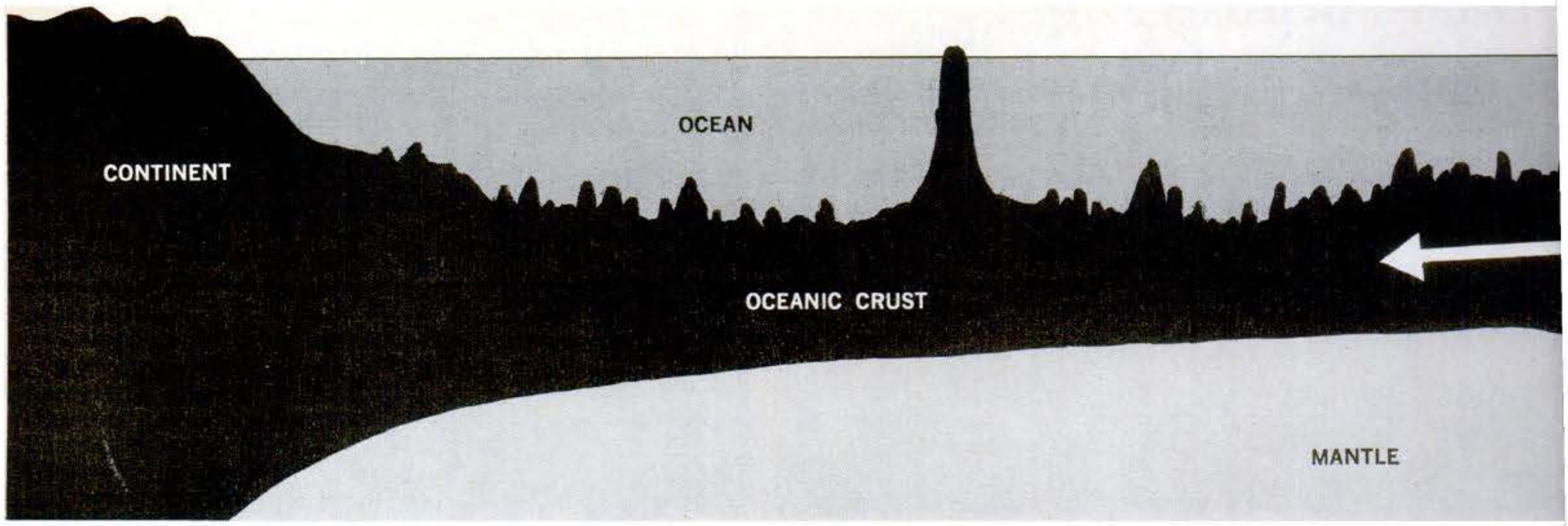

Sea-floor spreading is one of the most important mechanisms in movements of Earth's crust. Idealized sketch of oceanic cross section

PLATE TECTONICS—A Startling

Throw away the geology textbooks. The surface of our "stable" planet is in constant motion, with the very continents whirling, tilting, drifting, and plunging beneath our feet

By JOHN SPEICHER

Ever since men began to wonder, they have been asking themselves questions about the world they lived on. How did the mountains that towered above them arise? Why did the ground periodically tremble, often with dreadful results? Why did volcanoes sometimes disgorge a fiery red liquid?

As geologists learned more and more about the Earth, the questions changed, but the puzzles remained: Why do earthquakes rumble and volcanoes erupt most frequently in certain areas? Why are the remains of ancient sea-bottom creatures found atop the highest mountain—Everest? How account for the apparently capricious distribution of Earth's mineral resources? Why, for example, is there coal in Antarctica and oil in the Arctic—both residues of abundant plant growth typical of *warm* climates? Why are the deepest places in the seas—the trenches—near the edges of continents?

An answer to all the questions

Now a startling new theory not only answers all the apparently unrelated questions, but weaves our total geological knowledge into the first all-embracing picture of the Earth's past, present, and future.

Called *plate tectonics* (plate structure), it assumes that the Earth's crust is segmented into titanic blocks —or plates—the shape of inverted soup bowls and an average of 40 miles thick. There are some six major plates and about a dozen minor ones. They are in constant ponderous motion, riding over a semi-molten layer beneath them.

Thus *terra firma* is anything but. For the plates carry the continents piggyback, and us with them, erratically over the face of the Earth—and have been doing so for untold eons, at the rate of a half inch to five inches per year. The collision of these giants may leave enormous piles of wreckage—the Alps or the Himalayas. Or, as one plate slides beneath another, an unfathomable deep. From their inexorable grindings come seismic cataclysms.

This is a complete rewriting of Earth's history—geography run riot. Here are some of the astonishing conclusions of plate tectonics:

- All the continents were once a single supercontinent that began to break apart near the start of the Age of Dinosaurs, some 200 million years ago, with the pieces drifting in a global pattern that persists to the present. Thus the United States is getting closer to China, farther from Europe.
- All of the eastern United States was once part of West Africa, which collided with North America to form the Appalachians.
- Los Angeles will become a northern "suburb" of San Francisco in about 10 million years, eventually to disappear in the Aleutian Trench.
- Africa and Eurasia are moving together to obliterate the Mediterranean, which will be replaced by a chain of mountains, of which the island of Cyprus is just the beginning.
- The Alps were formed 20 million years ago when Italy, a protuberance of Africa, careened into Europe.
- Alaska once basked in the tropics; the Sahara Desert once was sited near the South Pole.
- The Himalayas were born when India, after zipping through the Pacific for millions of years at the heedless pace of four inches per year, bulldozed into Asia. On the way, India shoveled up a huge mound of ocean-bottom muck, which was then neatly left atop the world's highest mountain range—hundreds of miles from the sea.
- The sea floor is quite young—only 160-200 million years old, despite the Earth's age of some 4.5 billion years—and is being continuously created at one place only to "disappear" at another.

But perhaps the most amazing thing about the theory of plate tectonics is the suddenness with which

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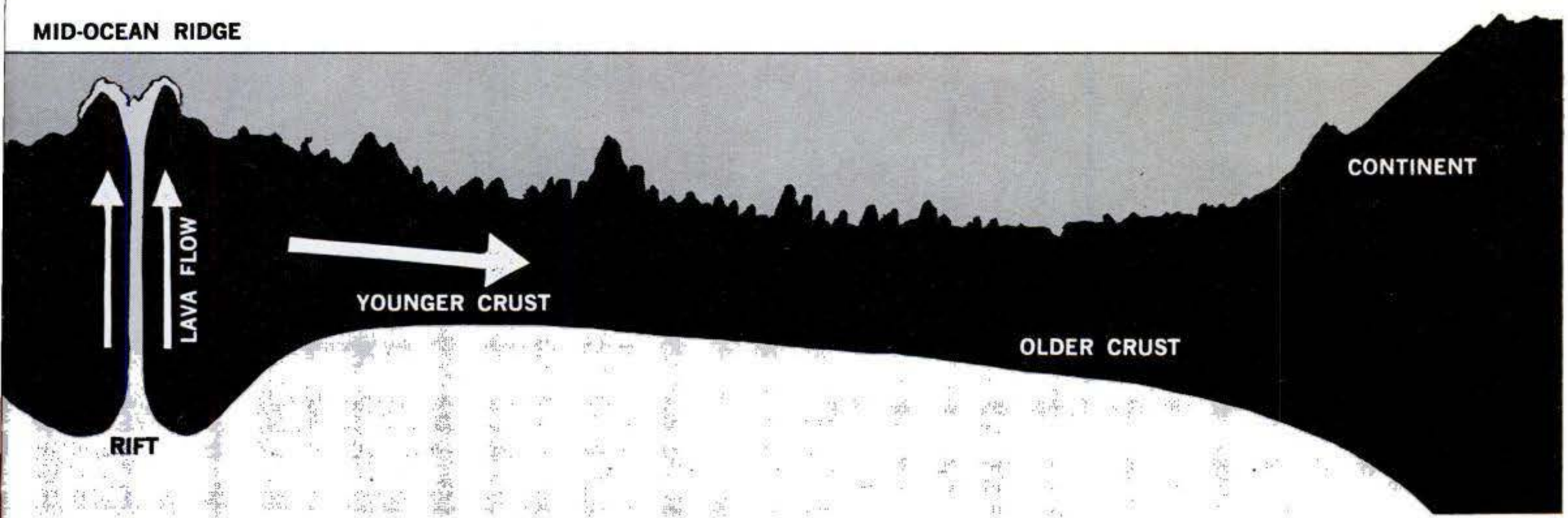

shows hot lava from mantle oozing up through rift to create Mid-Ocean Ridge, with new crust constantly pushing outward from Ridge.

New View of Our Turbulent Earth

it has become accepted in the scientific community. Only 10 years ago, it was a hare-brained idea, and a geologist who espoused it would just about have been drummed out of the corps. Today, the theory is the new bible of Earth science. This may be the fastest adoption of a revolutionary idea in the history of *any* science.

Matching jigsaw-puzzle pieces

No one has better reason for gratification over the rapid about-face than Dr. Bruce J. Heezen of Columbia U.'s Lamont-Doherty Geological Observatory, one of the theory's champions many years ago, when it was still generally called "continental drift."

"Back in the 1950s," recalls Dr. Heezen, "continental drift was as dirty a word to established geologists as Communism was to national politicians. If you supported 'drift' openly, then you had better have plenty of your own money to back your research, as well—because you'd lose your laboratory."

What was the gist of this radical theory? Take a look at a world atlas, and you may be struck by the way certain continental coastlines match up almost as neatly as jigsaw-puzzle pieces. One of the most striking fits occurs between South America's east coast and Africa's west coast. Down through the years, many theorists made the same observation and speculated about whether more than mere coincidence was involved.

One such theorist was a mercurial German meteorologist, Alfred Wegener. In the early years of the 20th century, Wegener proposed that the continents had once been part of a single supercontinent, which he named Pangaea. For some unknown reason, he said, the supercontinent broke up and its pieces became our present continents—drifting like rafts upon the Earth's surface.

Wegener depended on some highly controversial evidence to support his theory. For one thing, he made the amazing claim that prehistoric animal and plant fossils on different continents were related, indicating the continents had once been joined. Further, he insisted that the known facts about long-range changes in continental climates were best explained by assuming the continents wandered among different climate zones with the passing of the eons.

But more-orthodox scientists were scornful. Their chief objection: How could the continents move through the rigid rock of the Earth's crust?

In response, Wegener hypothesized that the mantle underlying the crust might be plastic in nature, rather than rigid, permitting the lighter continents—composed chiefly of granite only four-fifths as heavy as the dense basalt of the mantle—to wander slowly over the surface under the influence of centrifugal force and the tidal pull of sun and moon.

Other scientists speculated that heat given off by radioactive elements trapped in the Earth's interior rock could cook the mantle enough to give it a molasses-like plasticity, while convection currents welled up and fanned out horizontally to propel the continental rafts—much like the bubbles rising to disperse over the surface of a simmering kettle of soup.

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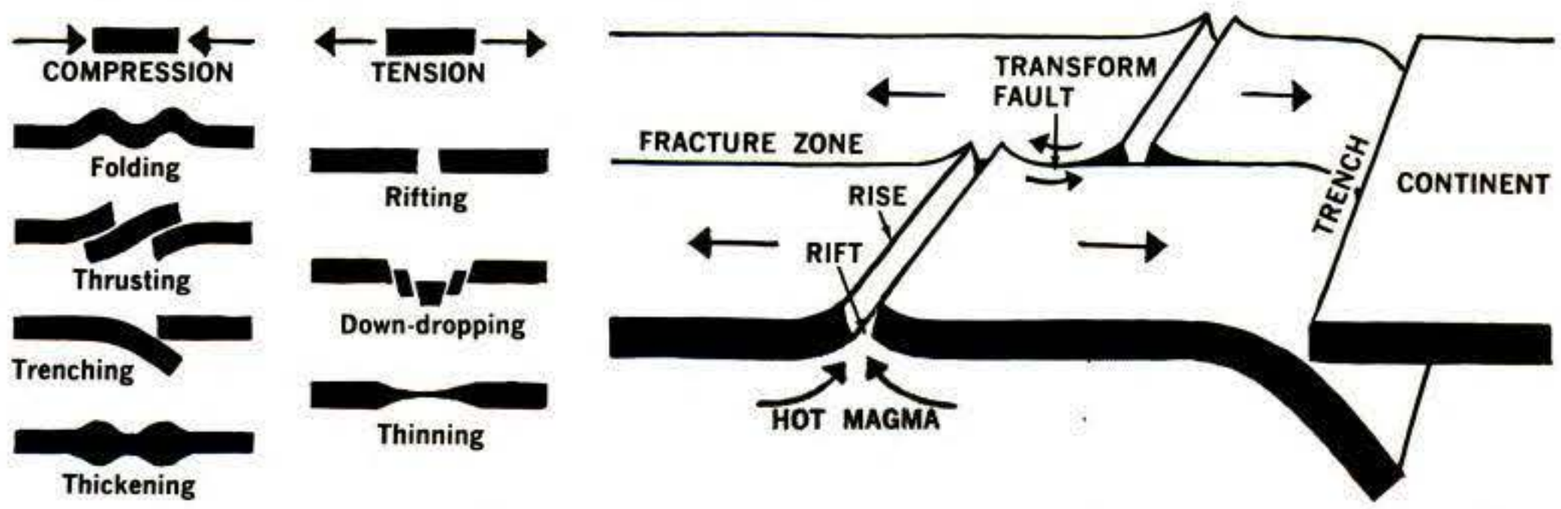
How moving plates create geological features



Plates change under compressive and tensile forces as shown above, accounting for variety of surface features. Rifting in ocean plates (right) allows upflow of magma, producing rise. Trenching occurs when plate hits continent; transform fault occurs when plates slide past each other. Earthquakes are symptoms of these three processes.

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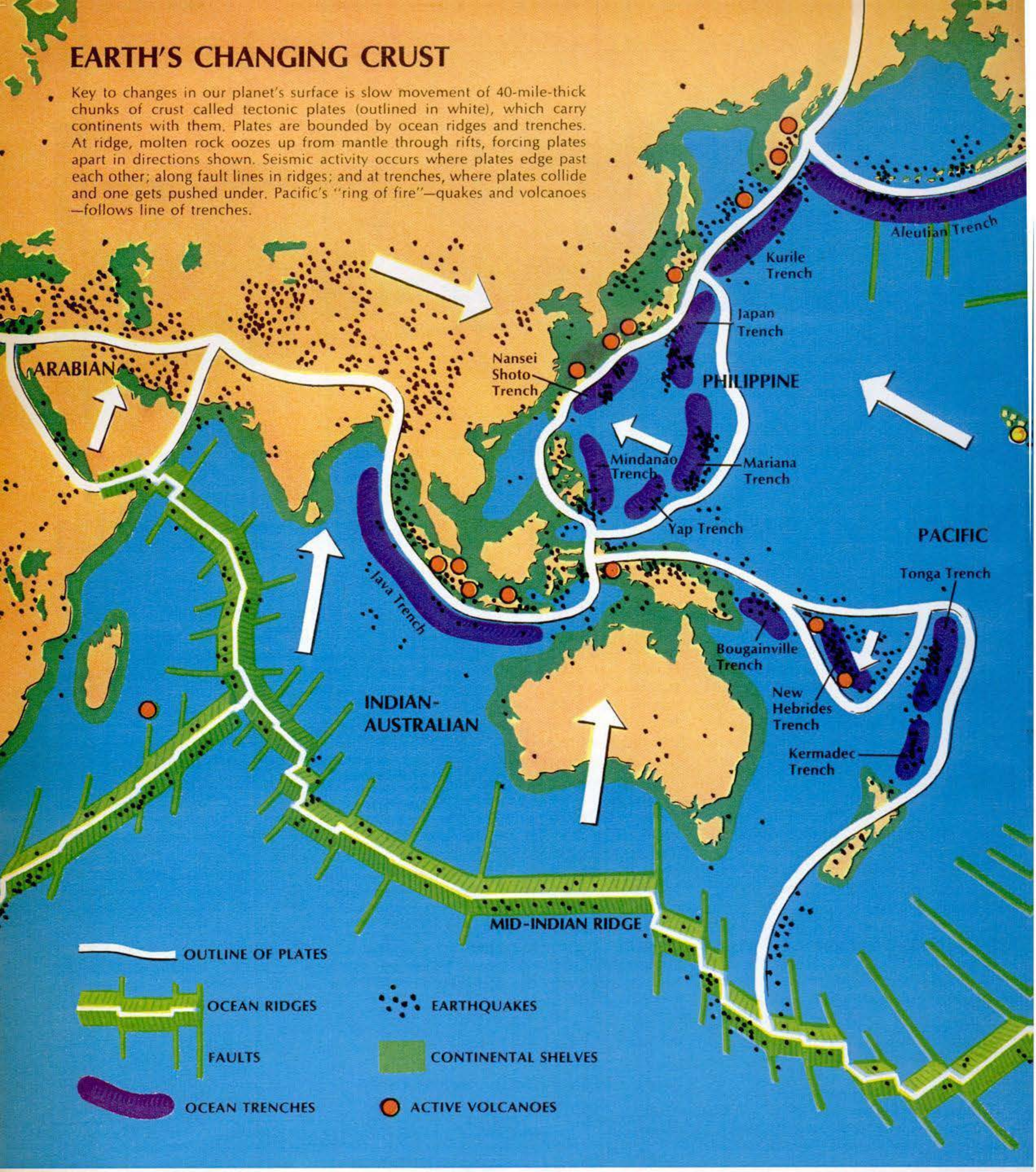
EARTH'S CHANGING CRUST

Key to changes in our planet's surface is slow movement of 40-mile-thick chunks of crust called tectonic plates (outlined in white), which carry continents with them. Plates are bounded by ocean ridges and trenches. At ridge, molten rock oozes up from mantle through rifts, forcing plates apart in directions shown. Seismic activity occurs where plates edge past each other; along fault lines in ridges; and at trenches, where plates collide and one gets pushed under. Pacific's "ring of fire"—quakes and volcanoes—follows line of trenches.



Decades later, a breakthrough

If such theories were correct, then there ought to be evidence of such convection: perhaps a deep break in the crust where molten rock constantly is slowly welled up from the Earth's hot interior. But, tragically, Wegener froze to death on an Arctic expedition without ever having located a site where any such activity seemed to be going on.

During the next 20 years, his theories were scoffed at as crackpot notions. Then, in the early 1950s, Bruce Heezen and a diligent co-worker, Marie Tharp, hit on something that breathed new life into Wegener's dusty thesis.

A number of transatlantic-telephone-cable breaks had plagued the world in the postwar years. Examining charts of the Atlantic sea floor where the cable lay, oceanographers Heezen and Tharp saw that all these snapped lines had broken in the vicinity of a deep rift, or valley, running down the center of a great undersea mountain range.

The range, named the Mid-Atlan-

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tic Ridge, divides the Atlantic into two nearly equal basins to the east and west, with the central rift varying between eight and 30 miles in width. Earthquake records showed that many quakes occurred along the rift, so it seemed that something mysterious was definitely going on there.

Dr. Heezen dug out every oceanographic chart he could lay his hands on. The Mid-Atlantic Ridge is but part of the great undersea mid-ocean ridge system that snakes out of the South Atlantic and up into the Indian and Pacific Oceans—some 40,000 miles long. Heezen soon discovered that, in fact, a "world rift system" existed—a deep gash, marked by persistent earthquake activity, running down the mid-ocean ridge.

Next, British oceanographer Sir Edward Bullard took a voyage around the world above the mid-ocean ridge, trailing a heat gauge on a line down into the rift. Bullard found that temperatures within the world rift were significantly higher than elsewhere on the ocean floor.

Here, then, seemed to be the evi-

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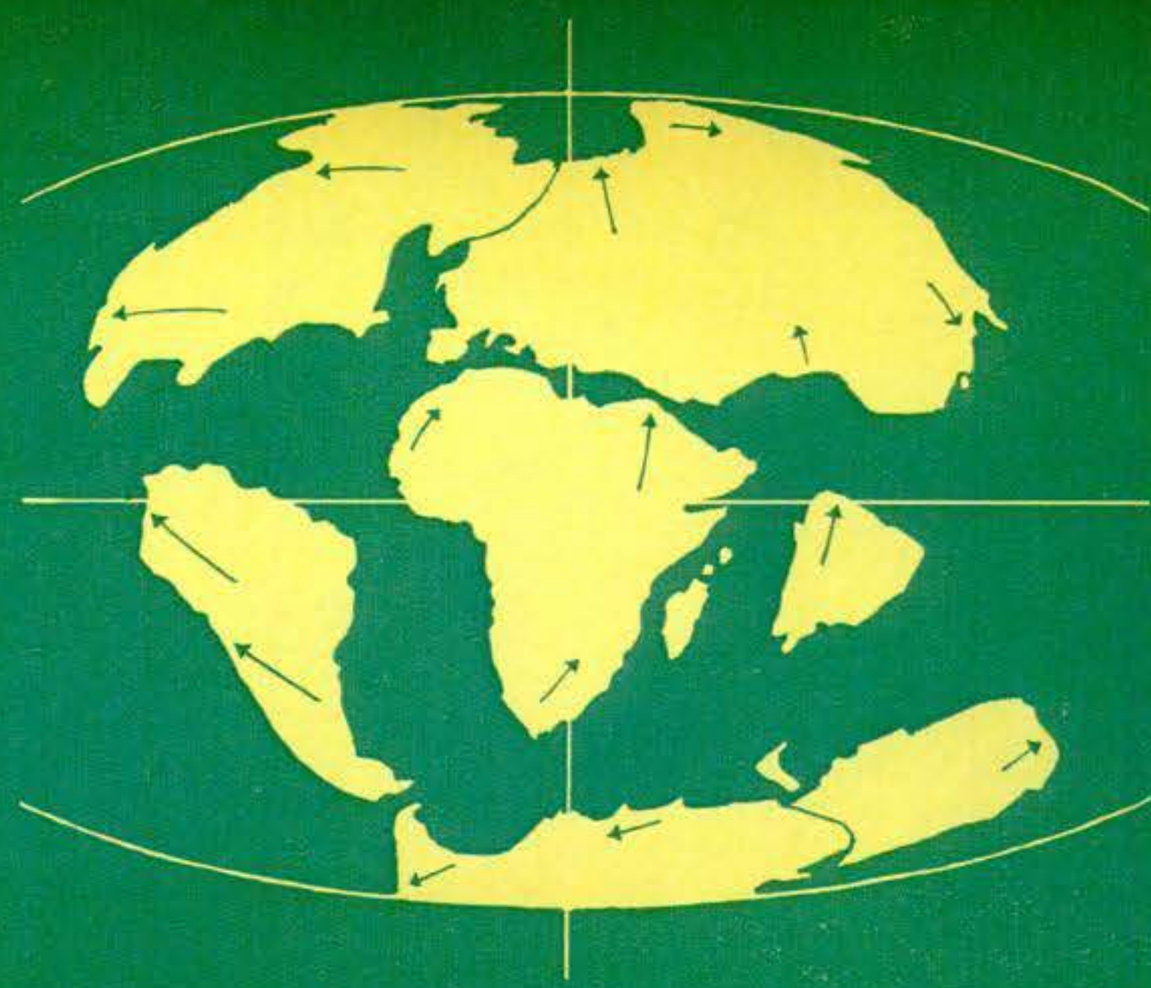

200 million years ago: Pangaea, the universal land mass, may have looked like this, according to reconstructions by scientists Dietz and Holden based on computer fits of continents' outlines.

65 million years ago: Continents have drifted apart, carried by moving tectonic plates. Major oceans have formed; India is headed for an impact with Asia; Australia remains attached in South.

dence Wegener had never found: a deep cut in the crust where molten rock welled up, triggering earthquakes as it forced the sea floor to move outward on either side of the mid-ocean ridge. And as the sea floor spread outward in great plates from the ridges, continents embedded in these crustal plates would also move.

"It seemed obvious," Dr. Heezen remembers today, "that the world rift could generate the wide-scale crustal movement required for continental drift. But the idea was hooted down at scientific meetings."

Heezen (together with Miss Tharp and his colleague Dr. Maurice Ewing) announced his discovery of the world rift in 1953. Several years later came further evidence that molten rock actually welled up there from the Earth's hot insides.

Unchallengeable proof

Beginning in 1957, new islands began erupting above the rift in the Mid-Atlantic Ridge; first in the Azores, then at the island of Tristan da Cunha in the South Atlantic, and finally, in November 1963, off Iceland, where Surtsey broke violently through the sea's gray surface in a steadily growing heap of flaming lava [PS, Oct. '65]. These demonstrations were unchallengeable proof that new rock was added to the crust at the rift.

The turning point in the controversy had arrived. No longer could sea-floor spreading and continental drift be rejected out of hand. Next, in 1965, the British scientists P. M. S. Blackett and S. K. Runcorn opened a window onto the remote past of Europe and North America.

They studied the magnetism of ancient rocks from the continents, finding that the land hadn't always stood in the same orientation to the North Magnetic Pole as today. While drift champions saw this as decisive support, Heezen recalls that "the mossbacks insisted all such large differences were caused solely by shifts in the Earth's magnetic field."

Despite the rigidity of the "mossbacks," many scientists had already subscribed—even before Blackett and Runcorn staked their prestigious reputations in support of drift.

Among these were Princeton U.'s Harry Hess, who early felt that new crust was added at the quake-prone rift; Canadian physicist J. Tuzo Wilson, who saw evidence of sea-floor movement in the straggling pattern of the Hawaiian Island chain; and Environmental Science Services Administration scientist Robert S. Dietz, who quickly pointed out that if new crust were being added to the surface of the Earth, somehow old crust must be removed to make room for it.

How, indeed, *is* old crust removed from the planet's surface? Using sonar echo-sounding techniques, oceanographers have mapped a number of deep trenches ringing the Pacific basin. The most dramatic are the Chile-Peru Trench on South America's western edge and the Japan, Mindanao, and Marianas Trenches at the side of the Pacific. Active volcanoes, young rugged mountain ranges, and earthquake zones mark the rim of the shrinking Pacific basin where the trenches are found—the so-called "ring of fire."

Plate tectonics experts hypothesize that these deep ocean trenches are literally great "disposal chutes." The oldest edges of the sea-floor plates plunge down the trenches to be consumed within the blast furnace of the Earth's hot interior.

Why do the trenches appear in a ring around the shrinking Pacific? As the Eurasian and North and South American plates inch outward from the Mid-Atlantic Ridge, they necessarily move toward one another on the other side of the globe—riding over the heavier basaltic plates of the Pacific basin. All along the edges of the Pacific basin, then, the heavy plates of the sea floor are being driven downward.

Visible results of trench activity

The trenches, therefore, are sites of enormous friction, accounting for the powerful forces of geological upheaval seen in their vicinity.

One recent theory proposes that the driving force behind continental drift may be delivered by some 20 huge "pipelines" carrying molten rock up to the surface from deep within the mantle. Dr. W. Jason Morgan, a geophysicist at Princeton U., thinks the 60-mile-diameter conduits are scattered about the globe and are clued by "hot spots" on the surface—places like the Hawaiian Islands, Iceland, and Yellowstone—all noted for dramatic geothermal activity.

Morgan's theory predicts that the pipelines should be found near the crests of rises and at the junctions of three plates. Recent heat measurements at such triple junctions have tended to confirm this idea.

Thus plate tectonics has vastly magnified the scope of the old drift theory—broadening it to encompass

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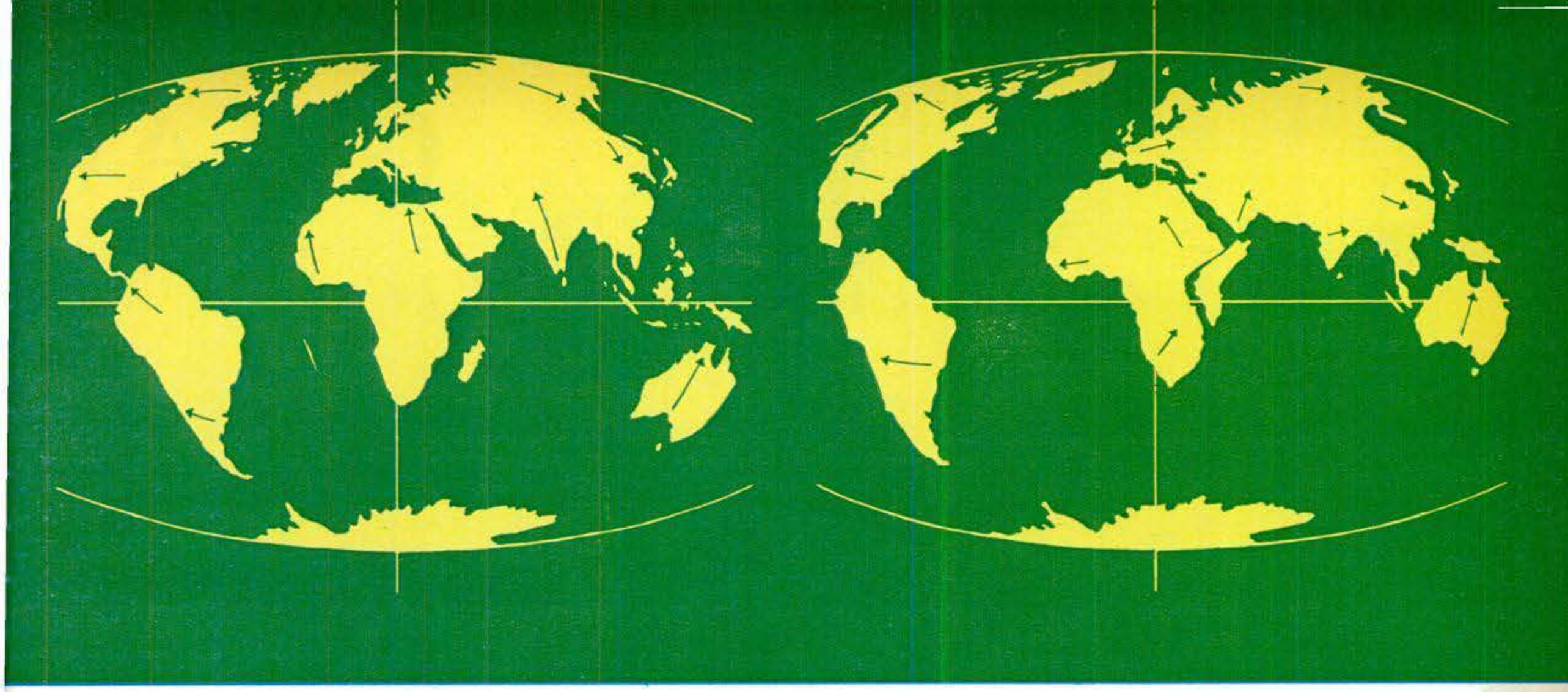

Today: Rift has opened North Atlantic to Arctic; India has slammed into Asia, creating Himalayas; Australia has left Antarctica; continents have drifted farther apart, creating new sea floor.

50 million years from now: Earth may look like this if continental drift continues as it has in past. Slices of California and Africa have split off; Australia is heading north; Atlantic is wider.

not only crustal-plate movements, but mountain-building, volcanism, and earthquake activity. And, in fact, almost all the former opposition to the theory has suddenly and politely vanished.

Why? Because of the abundance of interlocking evidence that researchers have come up with, in support of the picture in just the past several years. Some highlights:

- Antarctic fossils—unearthed in copious amounts only in the past two years—now unquestionably confirm that the frigid continent once lay in warmer latitudes. Moreover it must have been joined with other large land masses where the same species of terrestrial and freshwater life predominated. These species simply could not have migrated across the ocean barrier that now separates Antarctica from Africa and South America.
- Besides Dietz's work with computers, British scientists have plugged sonar profiles of most of the world's submerged continental shelves into a computer. Much neater "fits" than are obvious from the exposed coastlines of the continents have resulted, making possible a realistic jigsaw-puzzle reconstruction of ancient Pangaea.
- Visiting North Africa's Sahara Desert, a group of geologists, including Columbia U.'s Rhodes Fairbridge, identified miles-long parallel grooves etched into the desert rock.

The geologists agree that this is unmistakable evidence of grand-scale glaciation that could have been left only by an ice sheet the size of the polar caps that cover Antarctica and Greenland today. Africa, Fairbridge says, must therefore once have lain at the Earth's South Pole, perhaps as long as 450 million years ago, after which the continent migrated north to its present station.

- Measurements along California's San Andreas fault show that the slender sliver of land comprising the Baja Peninsula, San Diego, Los Angeles, and environs is moving northwestward at a rate of about three to four inches per year. Geologists say that this strip of California is not part of North America; rather, it is embedded in the great Pacific plate, which seafloor drilling shows also to be moving northwestward, at approximately the same rate.

Plate tectonics glimpses the future

California's quakes, say these geologists, result from the grinding of the Pacific plate along the edge of the North American plate—the line between the plates being the San Andreas fault. If the present movement continues, millions of years from now Los Angeles, San Diego, and Baja will exist as a narrow peninsula jutting into the Pacific off Seattle and Portland!

Each new investigation in plate tectonics makes it less likely that we will ever be able to return to our old cozy view of a stable planet with everything in its place.

Just within the past year, Dr. Heezen has come up with seemingly solid evidence that the sea floors are actually on the move as plate tectonics maintains they are. Along with Dr. Ian D. MacGregor, of the U. of California, at Davis, Calif., Heezen has been busying himself as co-chief scientist of the U.S. Deep Sea Drilling Project, sponsored by the National Science Foundation ["Glomar Challenger Drills a Peephole into Earth's Past," PS, May '71].

Off the Aleutians, scientists aboard the Glomar Challenger brought up bottom cores filled with a chalk never before known outside equatorial waters, where the tiny creatures thrive whose skeletons make up the chalk. Heezen found this chalk as far as 1,980 miles from the equator, concluding: "The sea floor once underlying the equator had migrated with time, carrying with it across the barren ocean depths relics of life that had thrived in another place."

Glomar Challenger drill cores are dated by radio-chemical methods, and thus far, Heezen says, no part of the ocean-bottom sediment appears older than about 200 million years. Terrestrial fossil evidence, such as that from Antarctica, suggests a similar date for the breakup of Pangaea.

Moreover, Heezen's team has found that sea-floor sediments near the mid-ocean ridges are invariably much younger than sediments near the trenches—a seeming confirmation that new sea floor is created at the rift in the ridge, spreading with time.

"I suppose," Heezen comments on the emerging view of our actively changing planet, "we're finally where geology would have been 60 years ago if anyone had listened to Wegener."

And where will we be, say, 200 million years from now? Some scientists think that in their movement toward one another over the shrinking Pacific basin the continents are headed for a reunion—that the breakup of ancient Pangaea was just one phase in a dynamic cycle of change that has continued unceasing since the crust hardened 3½ or more billion years ago. PS

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GREAT

Queen of test fleet, 24-foot Aquasport Sea Hunter is equipped with mini tower for sighting fish, has dual controls topside.

Twin 50-hp Evinrudes mounted on the 20-foot Wellcraft (left) made a sweet seagoing combination that was easy to handle.

Five-boat pass-by displays features in common: full bow, with footing forward for fighting fish; center console, walk-around cockpit; and all take outboard power. From left are Mako 17, Wellcraft 20, Aquasport 24, Mako 19, and Roballo 19.

Handy Bimini sun top covers most of ample cockpit space on Aquasport. Roe opens up the twin 125s, hustling to offshore grounds.

Roballo 19 sports a solid bow pulpit and twin fighting chairs aft that leave plenty of space when you stand to operate her.

Salty good looks of the Mako 17 match seaworthy hull qualities typical of the best of these boats. High-density polyurethane foam in Mako's upper hull sides makes her unsinkable. Outboard used in test is an 85, but less will move her.

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FOR THE CHASE

...those rugged inshore/offshore fishermen

Now wherever big fish inhabit big waters, you'll find these fishing machines in action

BY JIM ROE / *PS Boating Editor*

This rugged breed of boat handles both inshore and offshore fishing action amazingly well. It's designed to go out through the inlets in the morning, beat it offshore to where the fish are, stay on station safely for long hours, and come back in through those inlets at night. For a craft of perhaps 20 feet costing little more than a family wagon, this represents progress.

It's an equally good boat for running close inshore, near surf and reefs, or patrolling the big bays. It is controllable when the lookout has to be sharp.

The originals first appeared in the coastal waters of Florida, like many other popular designs, but now you'll find these boats off the shores of Maine and Texas, in the Great Lakes, and on the Pacific coast. There are many makes, and they're far from identical. Most have a modified deep-V hull. Lengths range from about 17 to 24 feet. They take outboard power, and all are trailerable.

Typically, there's a full bow, with a platform forward for fighting the fish. The central console is an effective location from which to control the boat, either sitting or standing. The man with a fish on his line can pass on either side quickly. Built-ins include rod holders, fish box, and live-bait wells; fighting chairs; and plenty of dry storage space where gear that's important to a serious fishing trip is always at hand but never under foot.

We tested seven boats. They are the Aquasport 24, Mako 17, Mako 19, Roballo 19, Starcraft 21, Tridyne 22, and Wellcraft 20. We tested in three different locations, spending a total of a week with these boats. We fished. We experimented with many different horsepower combinations and ran them at all speeds.

First tests were at Stuart, on Florida's Atlantic coast, where the Indian and St. Lucie Rivers meet and flow through the boisterous St. Lucie inlet. Offshore, the Gulf Stream offers all kinds of fishing and a variety of water conditions. At Stuart I joined Evinrude's Eldon Robbins and his photo crew to take a look at five boats, all rigged with new 1972 Evinrude outboards at the big OMC test station there.

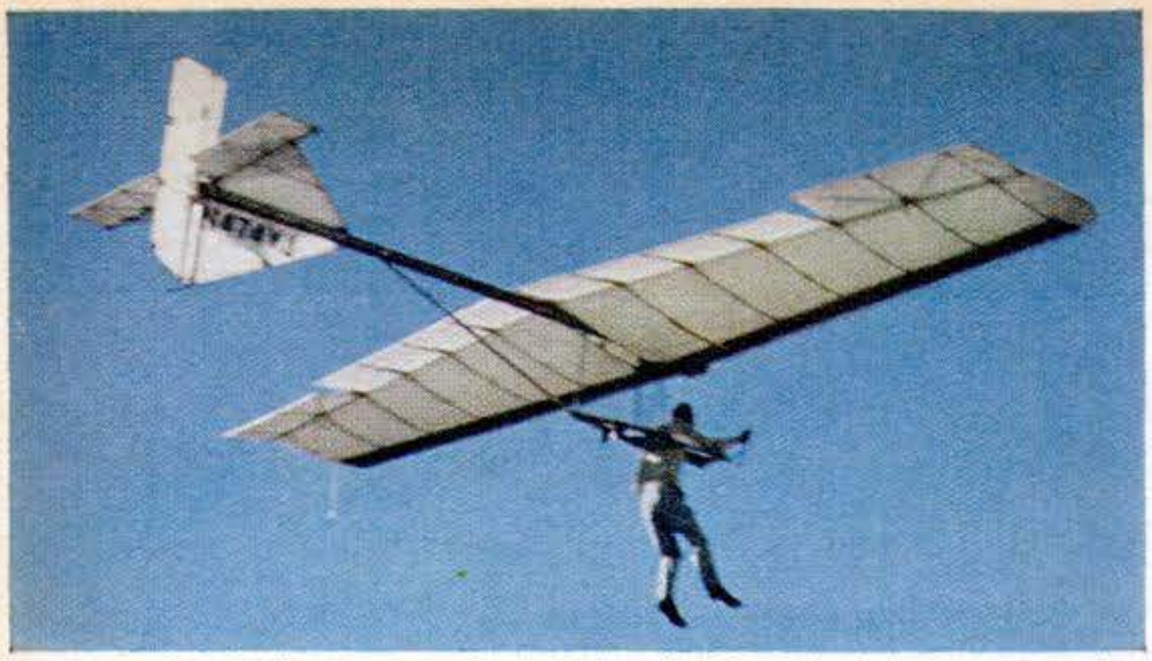
Largest: the Aquasport 24. She's named Sea Hunter, a nautical-looking

[Continued on page 134]

New hull design unveiled by Tridyne reduces drag and improves propulsion efficiency by as much as 10 to 15 percent.

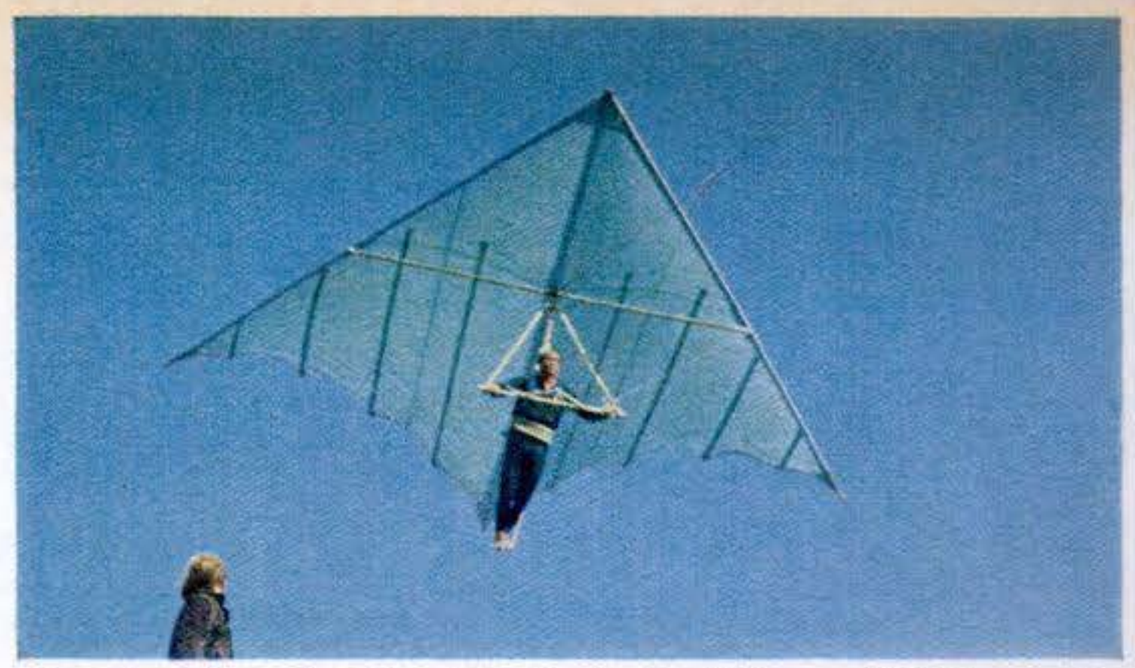
Starcraft 21 has aluminum lapstrake hull. Here she moves out with 100-hp motor, a transom buddy clamped on for trolling.

Their lines are trim, lean, almost arrogant—functional fishing machines stalking game in the Gulf Stream. Mako 19, Wellcraft 20.



Sexagenarian Volmer Jensen, who built his first hang glider in 1925, has soared for 5½ minutes in his new VJ-23. Joystick-controlled, cantilever monoplane has 32-foot span, weighs 100 pounds.

Over 7,000 hang-gliding fans have bought plans for "Hang Loose," the classic Chanute-type biplane designed by Jack Lambie. Here Larry Dighera flies his colorful version about six feet off deck.



Hovering almost motionless, Australian kite pro Bill Moyes displays complete mastery of Rogallo-type sailwing. Long battens in its 80° wing contribute to 18-foot hang glider's stability.

Barefoot pilot flying prone, Dick Eipper takes off with a 15-foot model of Eipper-formance Flexi Flier, a modified Rogallo of ultralight aluminum construction with a Dacron sail.

HANG GLIDERS— low and slow, and easy does it,

By PAUL WAHL

The skies over Southern California and other selected parts of the country have been dotted recently with strange shapes—and we don't mean flying saucers. They are bat-like and delta-winged, monoplane and biplane, put together with everything from metal conduit to bamboo. They skim over hillside and beach dune, low and slow, with human forms dangling from them, occasionally writhing antically.

These peculiar craft are hang gliders, engineless aircraft from which the pilot is suspended during flight—usually by his armpits. And hang gliding is a rapidly rising sport you can really throw yourself into—as you'll see if you come along on a trial flight.

First, you find a gently sloping hill that faces into the prevailing wind—a light breeze is a must. Air, moving with the wind, is deflected upward when it meets the hillside, creating areas of lift to windward. This lift is what supports the hang glider in flight.

Wearing your wings, you run a fast half-dozen-or-so

Continued

Getting into prone position, Bill Moyes (upper right photo, too) climbs into a rope loop that supports his feet. He's tethered to the keel by a waist harness.

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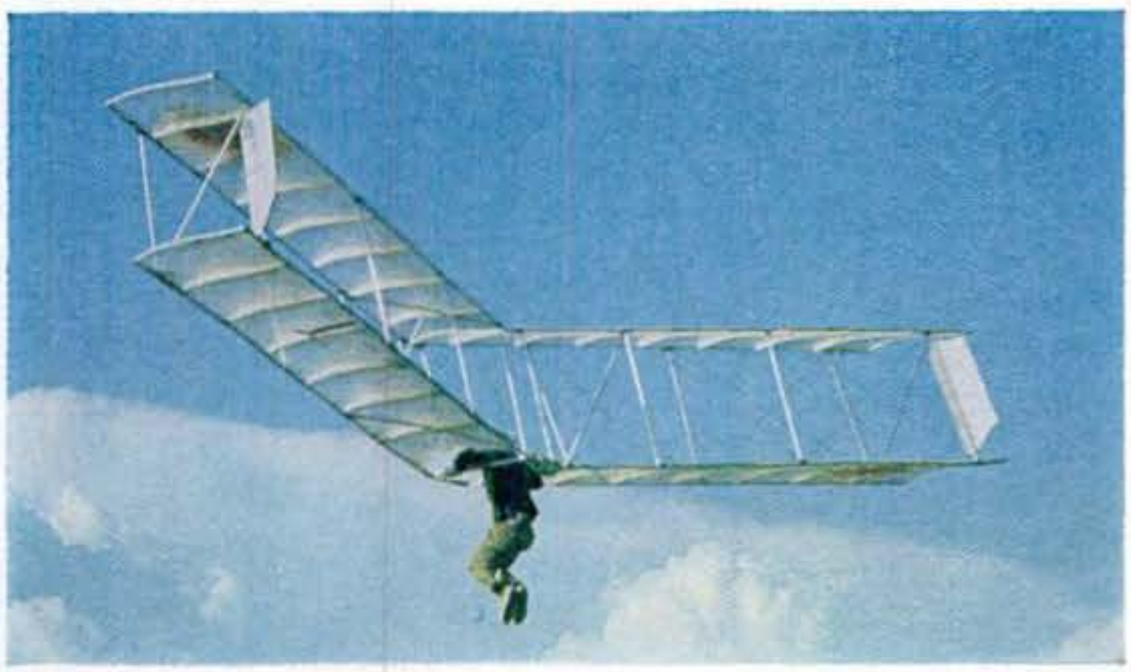
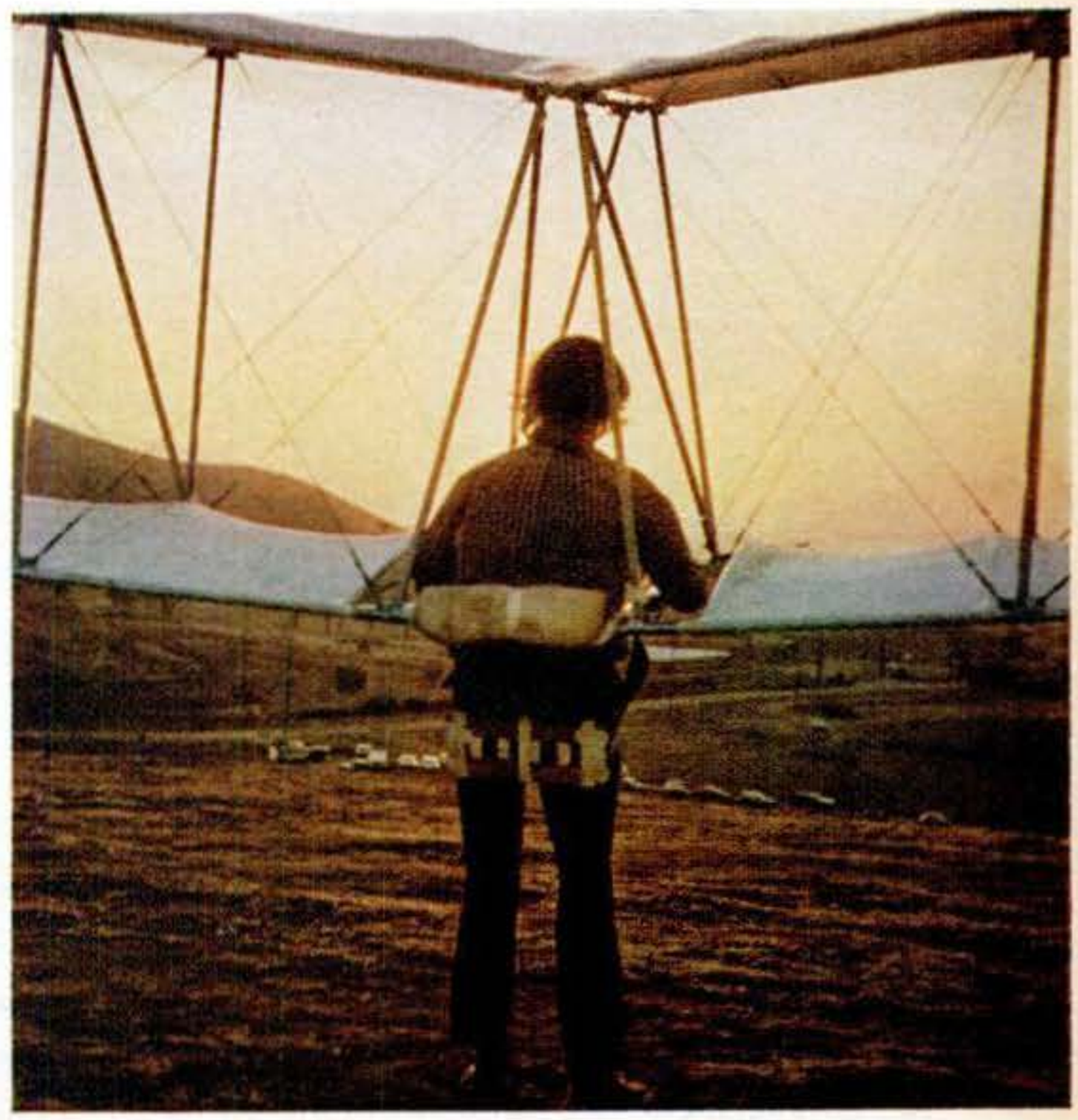
New Cronk Kite needs no wind for gliding. Dave Cronk is seen making a turn, his shoulder pressing a lever controlling a wingtip spoiler.

with these far-out, fly-yourself craft



Popular flying-wing Icarus was created by Taras Kiceniuk Jr., an outstanding designer-builder-pilot of hang gliders, when 18. The tailless biplane employs twist-grip-controlled tip-draggers.

No generation gap here: Pilots' ages range from 15 to 62 years. For this "family portrait," leading lights of the self-soaring set posed with their hang gliders on a California hillside.



Taras wearing his hang glider, Icarus II, weight 55 pounds. When airborne, pilot sits on a seat like that of child's swing.

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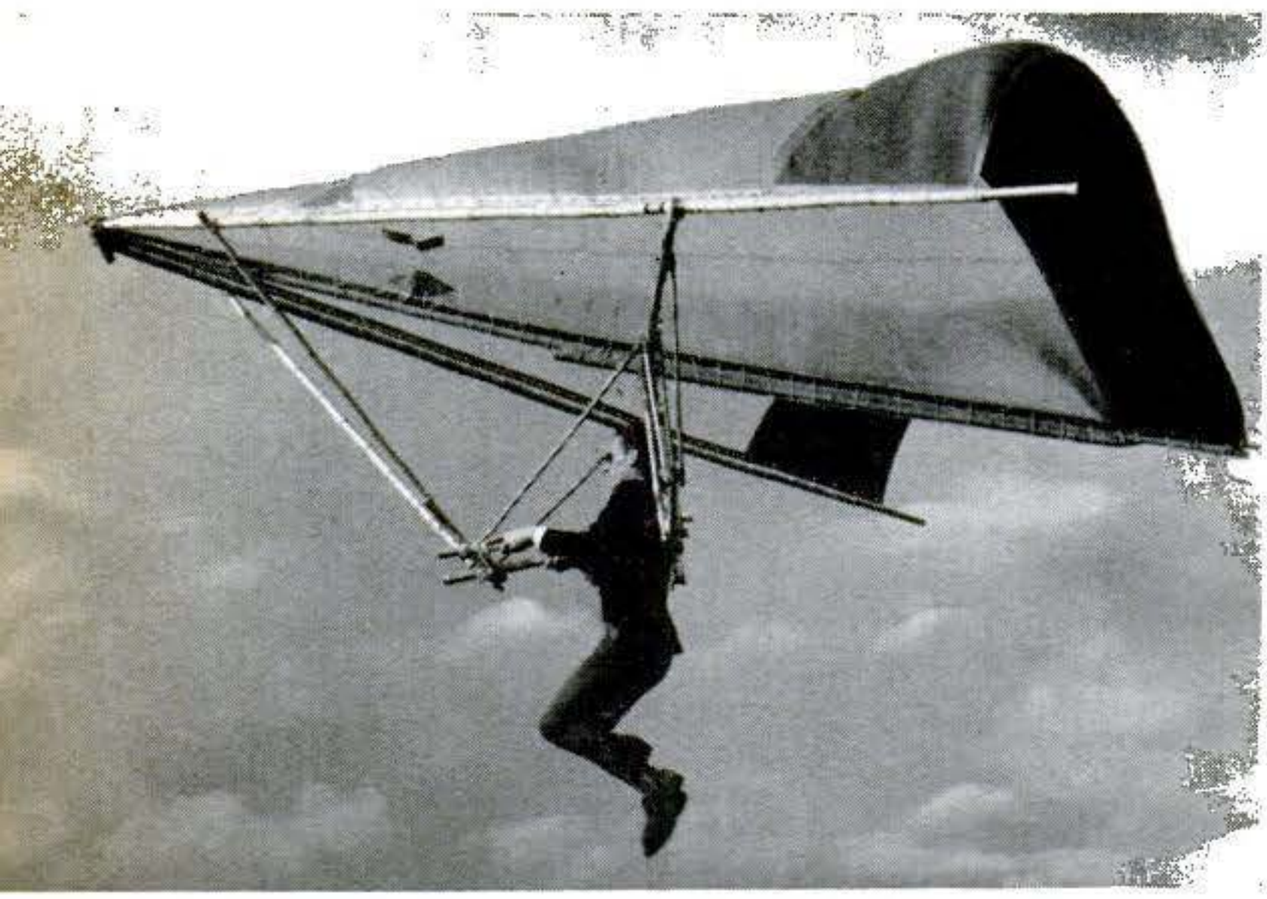
First Bamboo Butterfly cost $9 to build. Designed by Richard Miller, it was prototype of famous Bat Glider, a stiffened Rogallo sailwing for which over 12,000 sets of plans were sold.



Noted Swedish sailplane pilot Bengt Soderholm tries self-soaring for a change. Kite he is riding is a modified version of the Bamboo Butterfly—there's an added sail on its trailing edge.

Strange-looking bird is called the Conduit Condor—electrical conduit makes up most of its skeleton. Designer-builder Richard Miller says the 50-pound sailwing cost him a dollar a pound.

steps downhill into the wind, keeping the airfoil parallel to the slope. You take off by leaping out and down, quickly settling your weight forward. As the glider becomes airborne, you feel the tug of the wings. You're flying—self launched—like a bird!

Flight is controlled by body English. You shift your weight forward to drop and go faster, backward to rise and go slower; movement to the right or left turns the craft. To land, you glide down and level off with your feet about 24 inches from the ground. Gradually, you move your weight backward, settle standing up, after a few running steps. A gliding flight such as this will last about 15 seconds and carry you perhaps 250 feet.

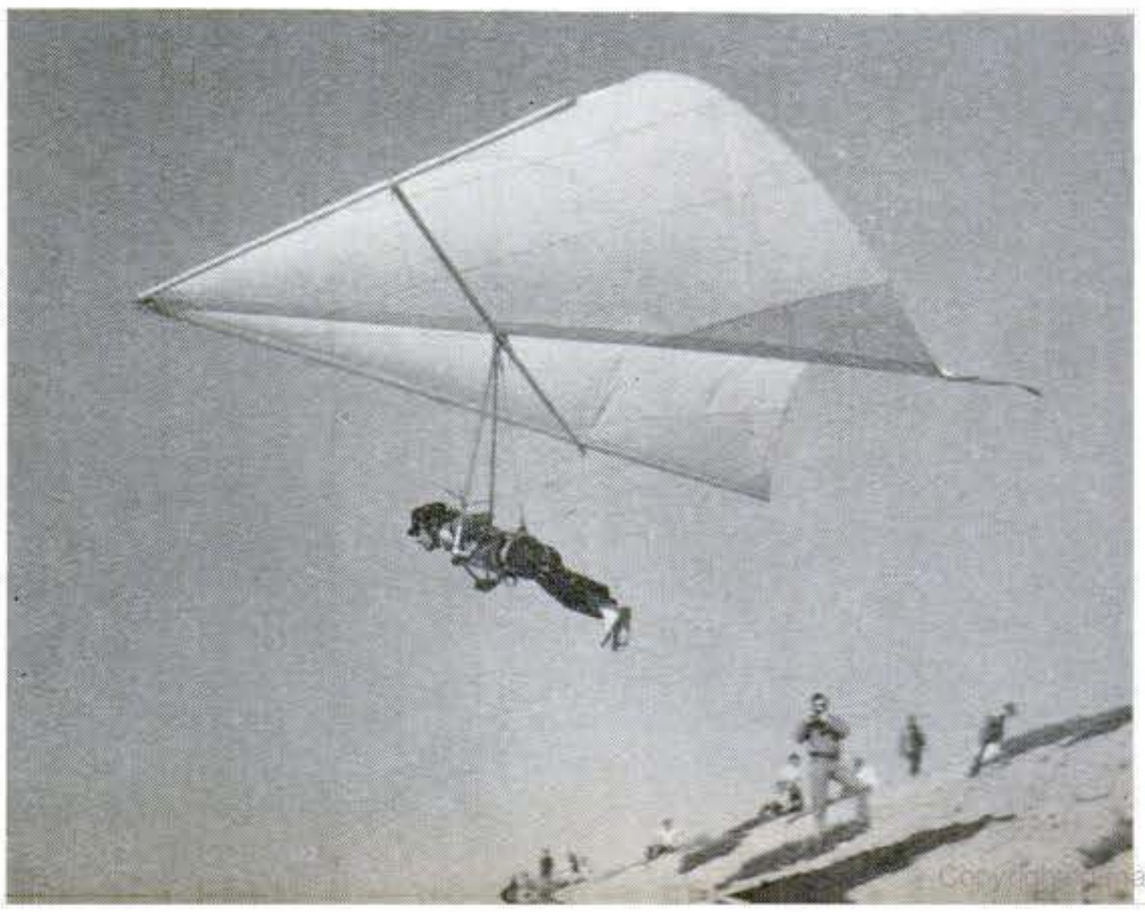
You fly low and slow. How low? Less than 20 feet above ground level—often a lot less. How slow? Average airspeed is in the neighborhood of 20 mph. Unimpressive numbers? Maybe, but those who have sampled both hang gliding and surfing rate the airborne sport as just as big a thrill. Indeed, today's hang-glider pilots like to call their sport "sky surfing."

For the advanced sky surfer, the ultimate trip is soaring—"ridge soaring" in sailplane pilots' parlance. Foot-launched, you fly in front of and parallel to the windward side of the ridge. Reaching its end, you turn away from the hillside, reverse your course, to land at the foot of the slope, below your starting point. Such a flight can last several minutes. Dave Kilbourne—known around Fremont, Calif., as "the Batman of Mission Ridge"—has made ridge-soaring flights as long as 64 minutes, as high as 2,500 feet, in a Rogallo kite of his own design. Self-soaring takes a good hang glider with three-axis control (yaw, pitch, and roll)—and a pilot with skill and guts (in that order).

Today's hang-glider pilots feel close to the sport's great pioneers. Each May, they gather in Southern California to celebrate Otto Lilienthal's birthday with a party and the biggest "fly" of the year. Lilienthal fathered hang-gliding back in the nineties. Although the big delta-wing kites that most sky surfers ride are modern developments, classic biplane designs are still popular with the tradition-minded. The Wright Brothers and their turn-of-the-century contemporaries would feel right at home in some of today's hang gliders.

"Hang loose" is what you do. So that's what Jack Lambie calls his version of the biplane glider that aviation-pioneer Octave Chanute built in 1896. Lambie, a California school teacher, originally designed this glider for a class project in aviation. He and a crew of 5th and 6th graders built the first Hang Loose on a $25 budget. After test-piloting the craft himself in 1970, Lambie published plans for this hang glider and sold over 7,000 copies. Reportedly, several hundred Hang Loose biplanes have been built and flown. Incidentally, TV watchers may remember the 1971 NET documentary of the Wright Brothers—Jack Lambie not only built the replicas of the Wright

[Continued on page 130]



"Kite-soaring with the birds is peace," says Dick Eipper, who recently demonstrated his hang-gliding skill for NBC-TV cameras. Kite is his 18-foot, $450 model of Flexi Flier.

A-Frame Gazebo:

Your outdoor activities center

It's easy to build, and lasts a lifetime without maintenance. The secret? Pressure-treated lumber

By A. J. HAND
PS Home Workshop Editor

Summer's here at last. Want to make the most of it? Move your activities outdoors to this A-frame gazebo, a sure-fire family pleaser. To your wife it's an outdoor entertainment center with room inside for a barbecue grille and picnic table. To the kids—a backyard playhouse. But to you it's a bargain in leisure living—easy to build and maintain.

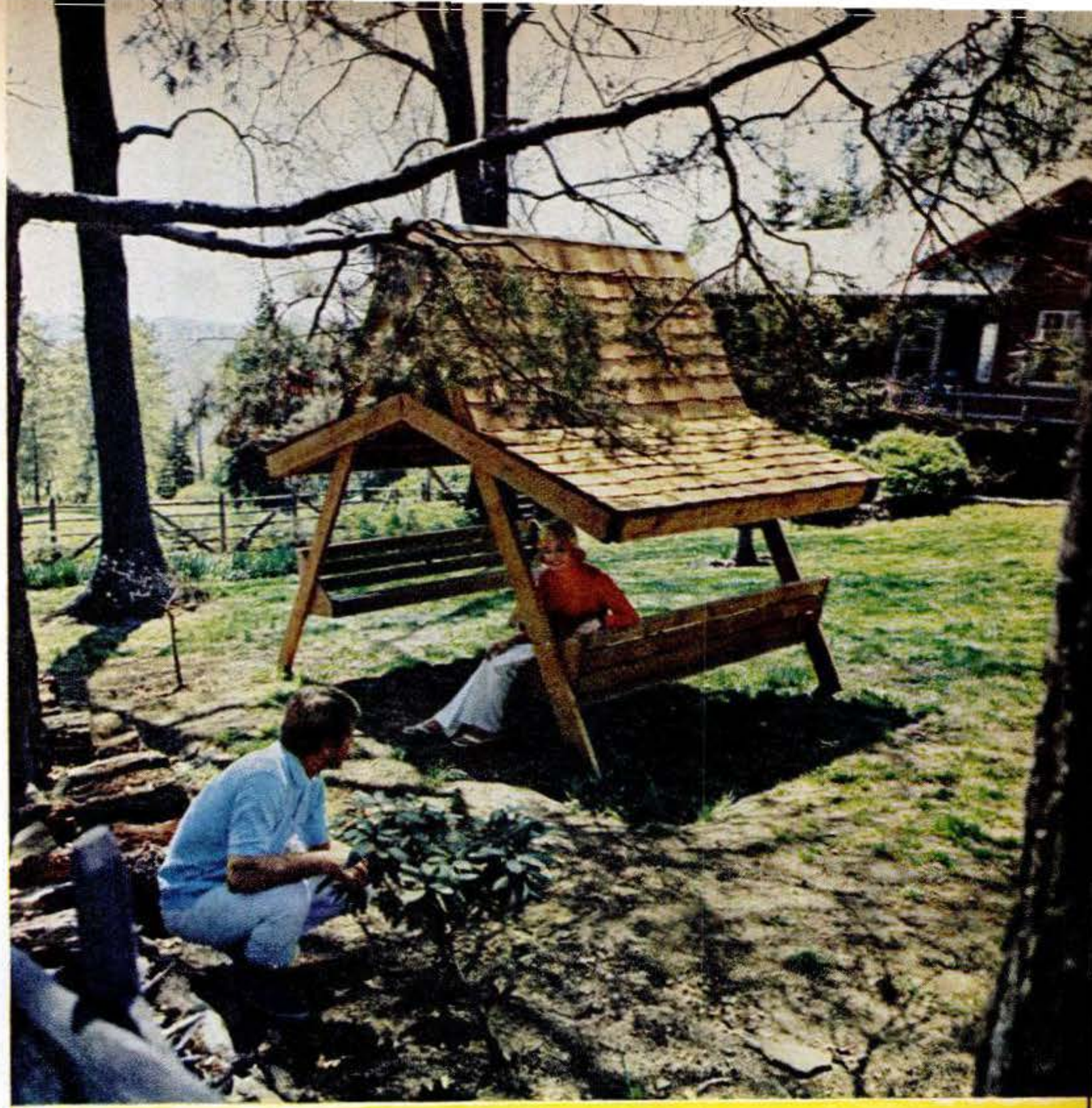
The Koppers Company designed it to go together quickly. You should be able to knock it off in a weekend. Tricky, time-consuming operations such as casting concrete footings have been eliminated. The frame anchors directly into the ground.

Once you've nailed the last shingle down your work is done—there's no need to paint. The lumber is pressure-treated with Wolman salts. As time passes, Wolmanized wood gradually weathers to a soft, silvery driftwood gray. But termites won't touch it; decay won't have a chance. Your gazebo should last a lifetime without maintenance.

Getting started. You'll need a fairly level piece of ground about 10′ by 14′. And a few simple tools—hammer, saw, square, tape measure, level, drill with 7/16″ bit, two adjustable wrenches, and a shovel, plus the materials at right.

You can work from our sketch, or send for free plans to Gazebo, Koppers Co., 1900 Koppers Building, Pittsburgh, Pa. 15219. Koppers' plans include step-by-step instructions, detailed assembly drawings, cutting diagrams, and roofing details.

Where can you get Wolmanized lumber? Ask at your lumberyard. If they don't stock it, check your local Yellow-Page listings—or write Koppers for your nearest dealer. PS



The materials you'll need

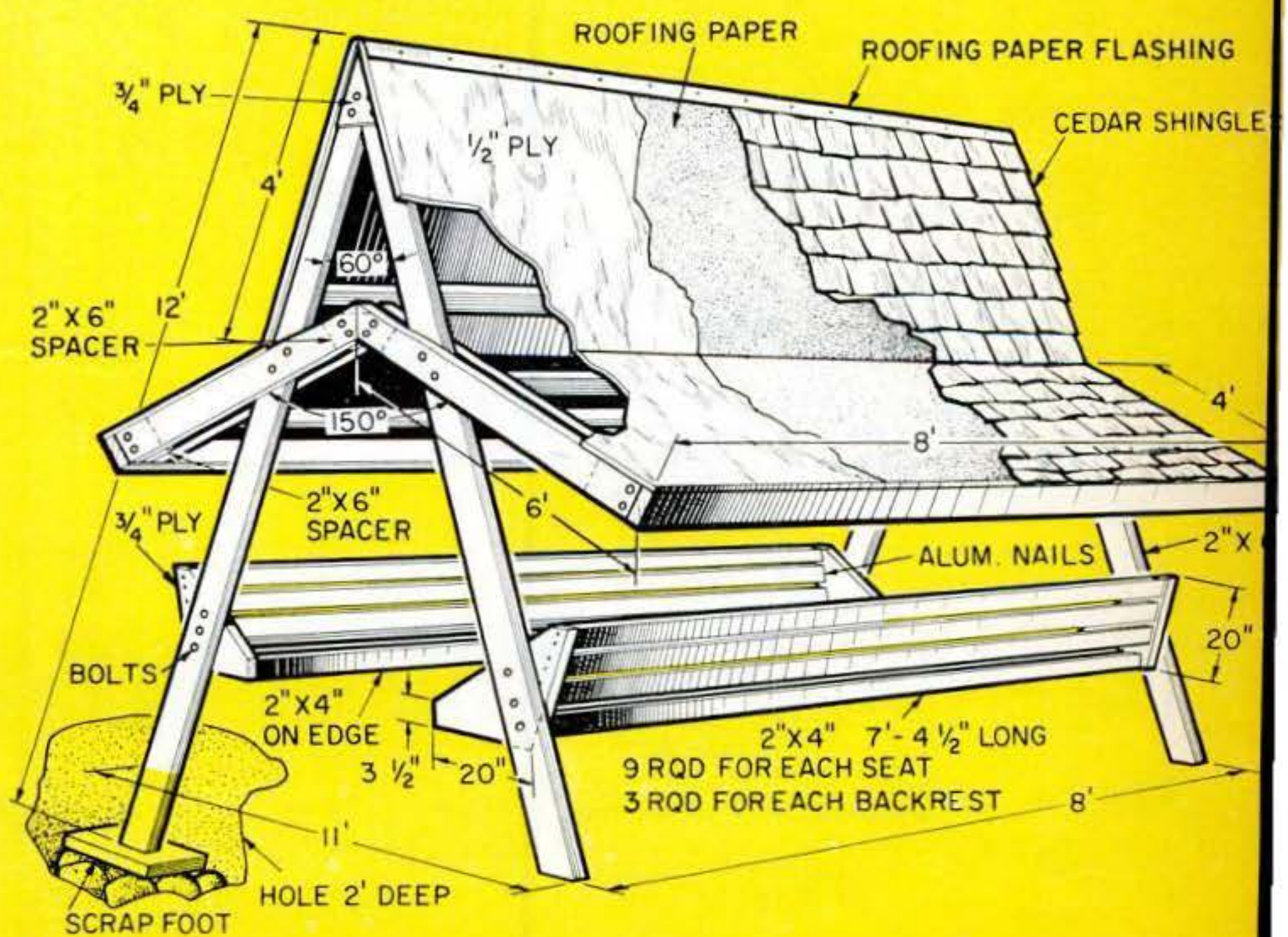
Wolmanized lumber:
28 8′ lengths two-by-four
Eight 12′ lengths two-by-six
Two 8′ lengths two-by-six

Exterior plywood:
Four 4′x8′ sheets ½″ plywood
One 4′x8′ sheet ¾″ plywood

Roofing:
1½ square cedar shingles (enough to cover 128 square feet of room with normal overlap)
Two rolls asphalt roofing paper

Hardware:
8 cadmium-plated machine bolts ¼″x4″
12 cadmium-plated machine bolts ¼″x3″
24 cadmium-plated machine bolts ¼″x5½″
44 cadmium-plated washers for ¼″ bolts
8 flush-type joist hangers
2 pounds 10d aluminum nails
2 pounds ¾″ aluminum roofing nails

Note: Since gazebo is left unfinished—to weather naturally—use no bolts or nails that will rust and discolor wood.



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Stable, functional, and fun—with over 100 square feet of deck space—it's hard to beat the powered pleasure raft for relaxation afloat. You can soak up the sun on the open deck or keep cool on your waterborne patio in the shade of the striped canopy.

Build a Powered Pleasure Raft

This summer, put your patio on the water. It's easier than you think

By BRIAN HARBURN

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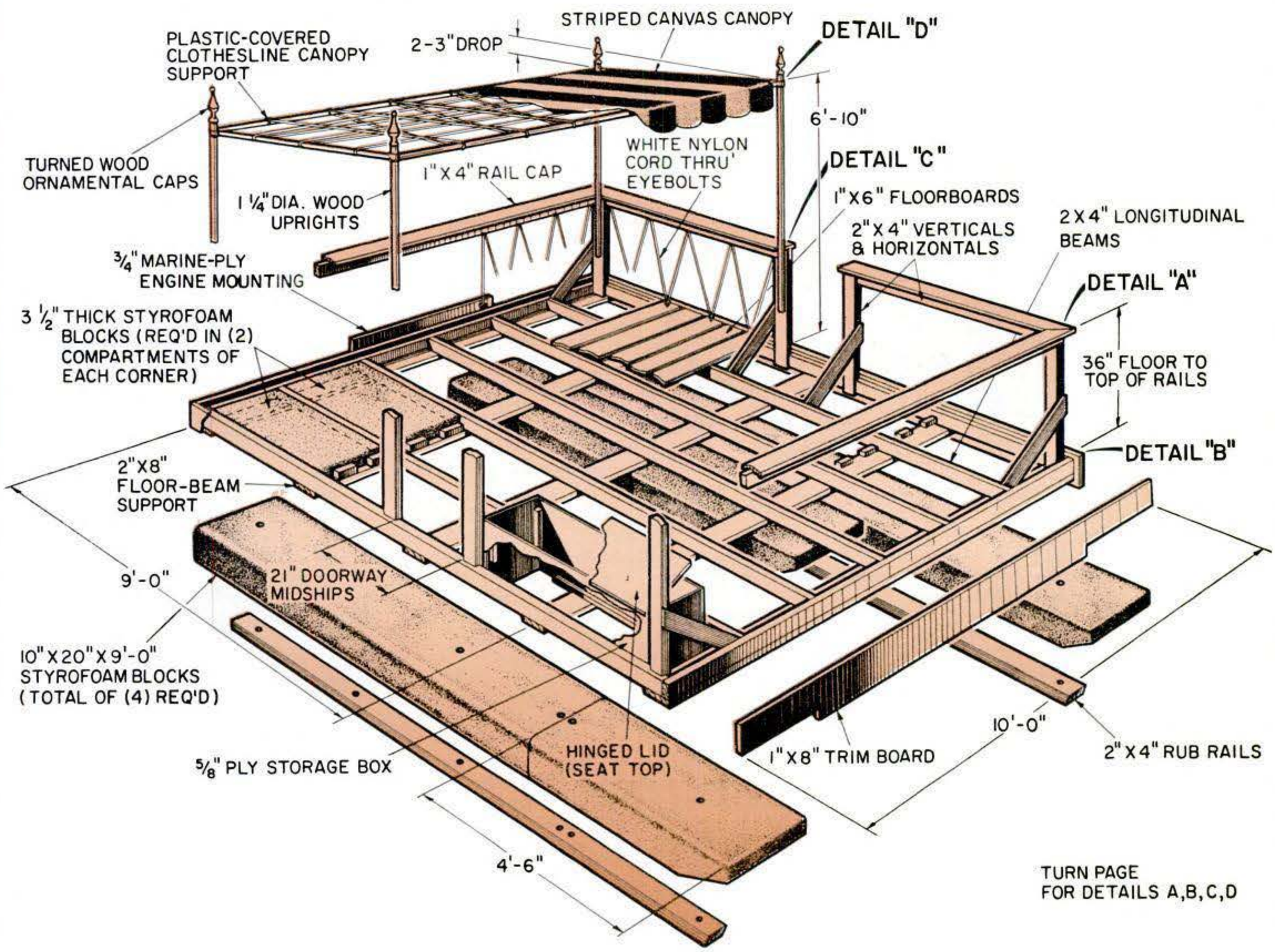
Want to go for a swim in the middle of the lake? Or invite your friends for a waterborne barbecue? Troll for fish or idly slip along shore enjoying the scenery? Build this 10-by-12-foot pleasure raft.

Mine cost me about $400, and went together in about two days, once all the parts were cut and finished. Power? Any light outboard will do. I use a little four-hp engine; steering is accurate and the raft will turn "on the spot." You can use a larger outboard, but anything over five horsepower is excessive for leisurely raft boating.

To make construction easy I've supplied step-by-step cutting and assembly instructions, and a complete list of materials. Buy all of these at one time and you may get a bulk-buy discount. When you pick out the lumber, look for the straightest wood you can find in the yard. I used cedar for its built-in rot-resistance, but fir treated with wood preservative liberally—before assembly—is good, too.

Once your raft is built and you've gotten to know it, you'll probably want to start adding accessories. By all means include a life preserver for everyone on board, an anchor, and a boarding ladder for swimmers. I added aluminum chaise lounges, and a round table with four stools. But my favorite addition is a pair of climbing rose plants in pots, complete with white trellises. In full bloom they never fail to draw the attention of passing boaters and onlookers.

Assembly is an easy 48 steps



1. Cut seven 2-by-4s 11'7¼" long. These are the lengthwise floor beams.
2. Cut two 2-by-4s 12' long and miter one end at 60 degrees across the 4" side. These go under the outer Styrofoam blocks.
3. Cut five 2-by-8s 10' long. These are the widthwise floor-beam supports.
4. Cut two 2-by-4s 10' long. These are the front and rear floorboard supports.
5. Cut two 1-by-8 planks 10' long, and two 12' long. These are the outer trim boards.
6. Cut the 25 1-by-6 planks 9'11½" long. These are the floorboards.
7. Cut the 4' length of 2-by-4 into seven pieces 5" long. They're "washers" for the bolts in the center flotation planks and the four floorboard supports at each of the vertical doorway rail supports.
8. Cut six 1-by-1s 15" long and four 1-by-1s 6" long. These are the retaining strips for the corner flotation blocks.
9. Cut four 2-by-4s 5' long. These are the side horizontal rails.
10. Cut two 2-by-4s 9'10⅜" long. These are the front and rear horizontal rails.
11. Cut eight 2-by-4s 39" long. These are the vertical rail supports.
12. Cut a piece of ¾" marine plywood 10"-by-36". This is the motor mount.
13. Treat all parts cut in steps 1, 2, 3, 4, 7, and 8 with wood preservative.
14. Sand smooth all floorboards (step 6) and apply two coats of varnish.
15. Cut needed notches in the horizontal and vertical rails to allow assembly as per figs. A and B (next page).
16. Sand and paint all vertical and horizontal rails and the motor mounting board. Paint the 1-by-8 trim boards the same color.
17. Assemble the vertical and horizontal rails with screws. Predrill and countersink all necessary screw holes including those for mounting the verticals to the side floorboard beams.
18. Cut eight pieces of Styrofoam to 3½"-by-18"-by-34".
19. Saw one of the 9' Styrofoam blocks into two equal lengths and saw one end of each at 60 degrees (but leave a 3" snub nose, as per drawing). Miter one end of one 9' block in the same manner.
20. Drill holes in the 2-by-8s (step 3) at all bolt locations.

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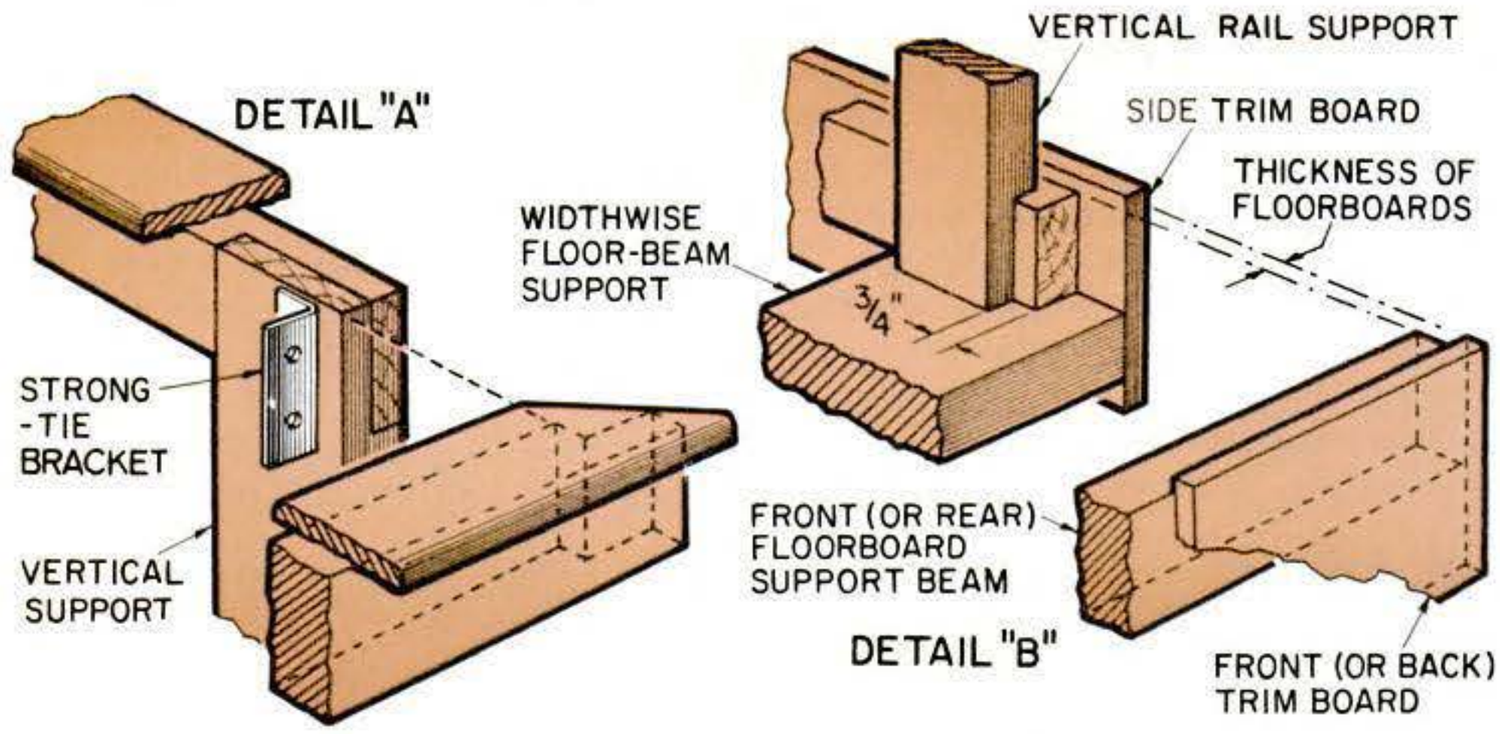
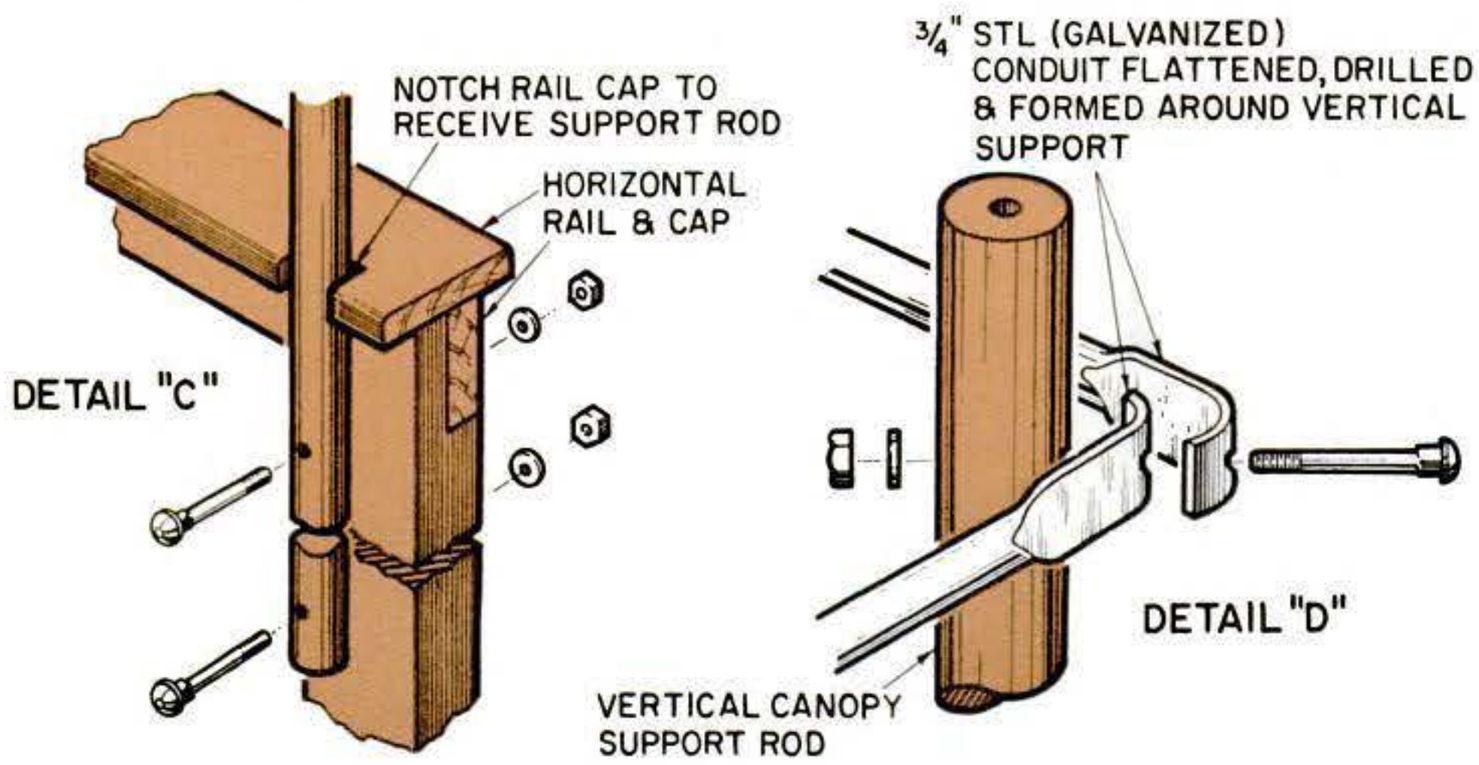
Step-by-step guide to assembly [Continued]





21. Drill one hole in three 5" 2-by-4s (step 7). Also drill and countersink holes in the four other blocks of step 8 for screwing to verticals.

You're now ready to assemble the raft. You need a rather large flat area, preferably close to the water.

22. Place the Styrofoam floats in roughly correct position.

23. Place the 2-by-8 crossbeams on top of the floats and carefully line up and position floats and crossbeams, as in drawing.

24. Mark through the holes in the 2-by-7s onto the floats.

25. Bore holes through the floats. A carriage bolt ground to a point can be easily pushed through the Styrofoam.

26. Now lay the two 12' long 2-by-4s (step 2) on the ground and place the correct Styrofoam blocks on top of them. Mark the correct location of the bolt holes in the 2-by-4s through the Styrofoam blocks.

27. After drilling, put the carriage bolts through the two 12' long 2-by-4s and the three 5" long 2-by-4s and slip the Styrofoam block onto the bolts.

28. Assemble the five 2-by-8s over the bolts, adding washers and nuts loosely.

29. Place front, rear, and two side 2-by-4 floorbeams on the 2-by-8s. They assemble flush with edges and ends of the 2-by-8s.

30. Lay eight 90-degree strong ties on the inside against the 2-by-4s and 2-by-8s, (two to each side, front, and rear) about 15" from each corner. Pencil the outline of the ties on the 2-by-4s and 2-by-8s.

31. Remove the front 2-by-4, nail the ties on it as marked. Do the same for the rear and both side 2-by-4s.

32. Nail front and rear 2-by-4s in place, making sure sides and ends remain flush with the 2-by-8s. Recheck for squareness and nail side 2-by-4s in place.

33. Now nail the strong ties to the 2-by-8s.

34. Tighten all the nuts when you are sure everything is square.

35. Drive a couple of nails at each corner joint of the 2-by-4s (not into 2-by-8s).

36. Place the five remaining 2-by-4 floorboard supports at equal distances and nail in place through front and rear 2-by-4s. Firmly secure these in place by nailing a strong tie at each point where they cross a 2-by-8.

37. Now assemble the railing. Loosely screw all four corner verticals to the raft; note you must allow ¾" gap for the corner braces. Assemble and loosely screw front and rear horizontal rails to the verticals. Pre-assemble and screw together the four doorway verticals to their respective side horizontal rails. Be sure they are square before tightening screws. Now position each of these assemblies onto the raft and loosely screw them to the raft base and corner verticals.

38. Tighten all screws and fill with wood putty.

39. There is a brace at all corner verticals and two more at the door verticals. Measure and make these from 1-by-4 stock. Paint or varnish them prior to assembly.

40. Now position the eight blocks of Styrofoam into two compartments of each corner and secure them in place with the 1-by-1 strips cut in sequence (step 8).

41. Screw into position the four auxiliary floorboard supports (seq. 7) at the base of the door verticals. Note: Upper edges must be level with the upper surface of the 2-by-4 floorboard supports.

42. Nail into position the rear 1-by-8 trim board. Note: Upper edge must be higher than the 2-by-4 by an amount equal to the floorboard thickness (¾").

43. In a similar manner, nail on the front and two side trim boards—except you must first measure and cut a notch in the ends of the front board to clear the flotation blocks.

44. By now you should have the corner braces painted or varnished. Screw these into position. At the doorways use strong ties where they meet the 2-by-4s.

45. Lay all the floorboards with a gap of approximately 3/16" between each board. Notch those boards where the braces and vertical supports interfere. Then secure in place with two nails at each point where the boards cross the 2-by-4s.

46. Using 1-by-4 cedar, measure and make rail caps. Drill and countersink and radius upper edges. Also at this point cut notches to give clearance for the canopy support rods. Varnish and screw in place.

47. Make and install seat lockers.

48. Install canopy and canvas cover as detailed in the drawings.

Checklist of materials you'll need to build your raft

LUMBER:
Two-by-four—nine 12' lengths
Two-by-four—six 10' lengths
Two-by-four—one 4' length (for cutting into 5" lengths)
Two-by-four—eight 3'4" lengths
One-by-eight—two 12' lengths
One-by-eight—two 10' lengths
One-by-four—two 10' lengths
One-by-four—six 6' lengths (two to be cut up for corner bracing)
Two-by-eight—five 10' lengths
One-by-six—25 10' lengths
One-by-one—finishing lumber, 24'
Exterior plywood—2½ sheets 4'x8'x⅝"
Exterior plywood—one pc. 3'x15"x¾"
Wood poles—four 1¼"-diameter, 6' long, and four ornamental wooden knobs

CONDUIT:
Two 10' lengths ¾" plated steel
Three 5' lengths ¾" plated steel

HARDWARE:
Four mooring cleats
55 ½"-diameter screw eyes
400 1½" plated nails
50 1¼"-long screws
Eight ¼"x3" carriage bolds with nuts and washers
Four ¼"x2" carriage bolts with wingnuts and washers
Four ⅜"x4" carriage bolts with nuts and washers
16 ½"x16" carriage bolts with nuts and washers
40 90-degree-angle strong ties
Two brass or aluminum hinges 4' long, with screws

MISCELLANEOUS:
Four 10"x20"x9' long Styrofoam blocks treated to resist gas and oil (obtainable from Western Insulfoam, 3518 Iowa S.W., Seattle)
150' plastic-coated clothesline
135' white nylon cord
One pc. striped canvas 6'x12'
One gallon varnish
One gallon paint
One gallon wood preservative

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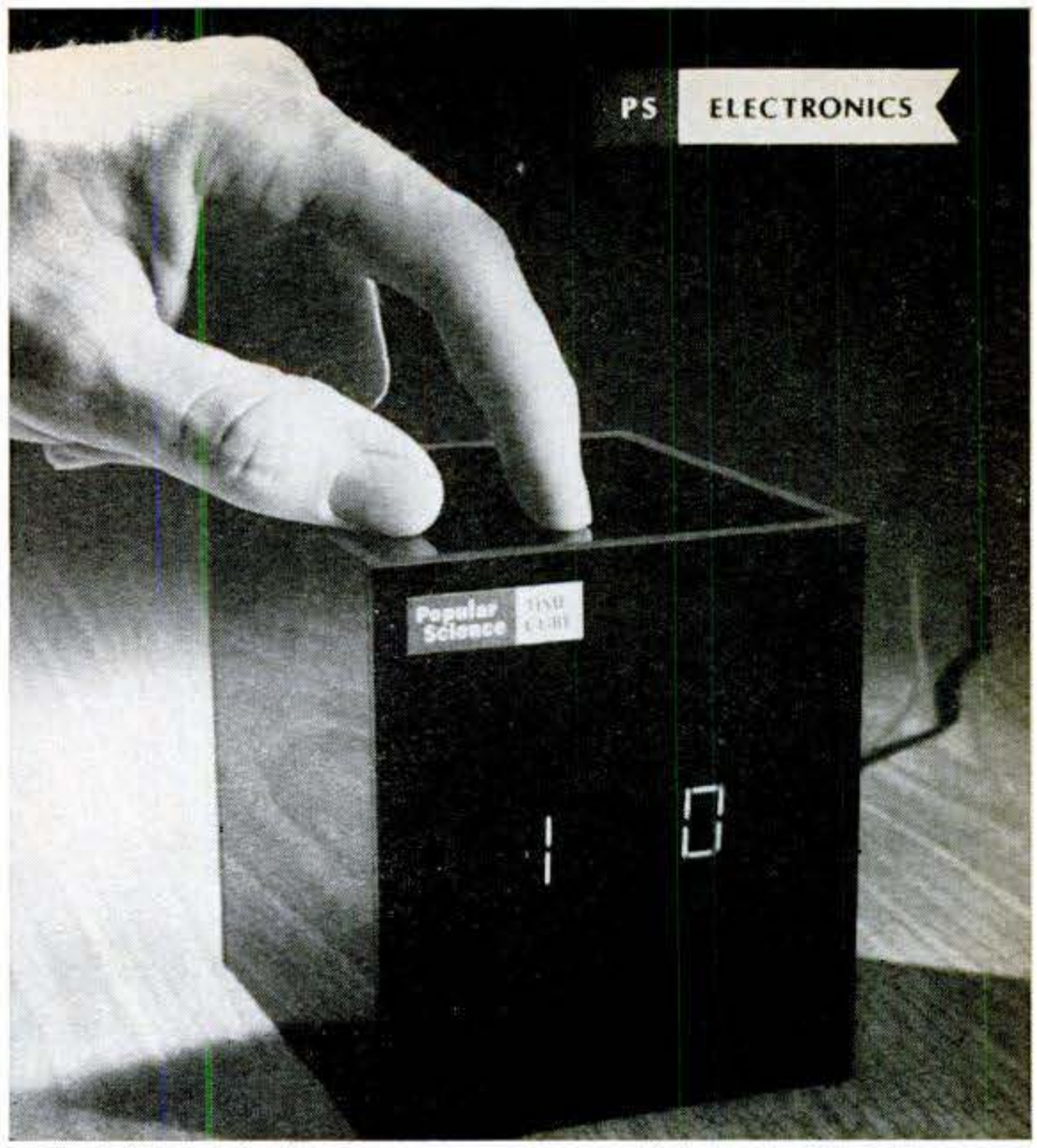
TIME CUBE— A Unique Digital Clock You Can Make



Three modes make this a triple-threat clock that reads time as you would speak it

By **WILLIAM J. HAWKINS** / *PS Electronics Editor*

Here's an electronic digital clock that's not like any other you've seen. Normally, the smoky Plexiglas cube is completely dark. Then, at a time that you've selected, two digits appear on its face: For example, 09. A second later, two others take their place: 12, say. And, after another second, these are replaced by a third pair: 43.

The cube has read out the time as you would speak or write it; first hours, then minutes, and finally seconds (09:12:43). After the time has been given to you, the cube again blacks out. And, on the hour, the Time Cube sounds a pleasant ½-second buzz.

When it reads out the time is up to you. A switch underneath the cube gives you three choices:

- Manual. This position is perfect for the bedroom. Whenever you want the time, push down on the top (as in photo above), then let go. The cube will display the hours/minutes/seconds, then automatically go black.
- Automatic. Now you've got a TV clock. The cube will display the time every 10 seconds, going black in between the scans. And, if you should touch the top between one of its 10-second scans, it will display the time at that point, then return to its automatic state.
- Seconds only. Use this in the photo lab or for timing the perfect three-minute egg. In this position, the cube will constantly display seconds, counting, one second at a time, from 00 to 59 and then returning to 00 to start again. And, since the clock circuitry still keeps track of the time, you can flip back to one of the other positions whenever you wish for the correct time.

What makes it tick? It doesn't. The cube keeps silent track of the time by counting the number of cycles from your house current. The 60Hz signal is taken from the power-supply circuitry and fed to a filter circuit, called a Schmitt trigger, which protects against false signals from transients on the line.

The signal is then passed through a dividing circuit which first divides the 60Hz by 6, equalling 10; then dividing it by 10, which results in one cycle per second. These 1Hz pulses are then totaled, divided into seconds, minutes, and hours, and stored in the counting registers.

When you ask for the time, or when 10 seconds have passed, the scanning circuitry turns on the readout tubes and sequentially looks at the hours/minutes/seconds registers. It then forwards the information from each register to the display decoder/drivers, which decode the information and display the correct number on each readout tube.

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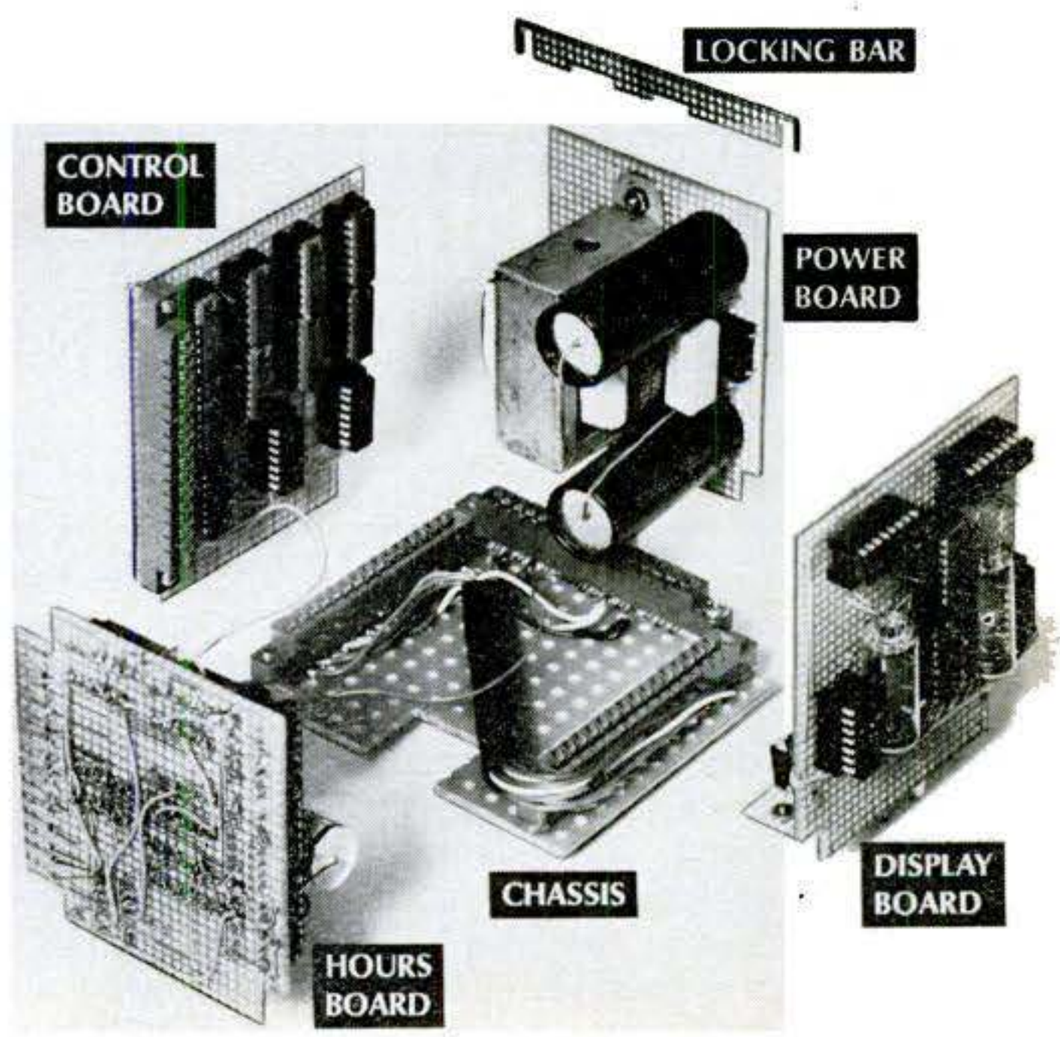

Modular construction simplifies assembly. Make each section in order, checking fit as you go. Locking piece fits slits in Control and Display boards, allowing Power board to rest against it. This holds all boards straight up and slightly out to prevent shorts between wiring of one board to another.

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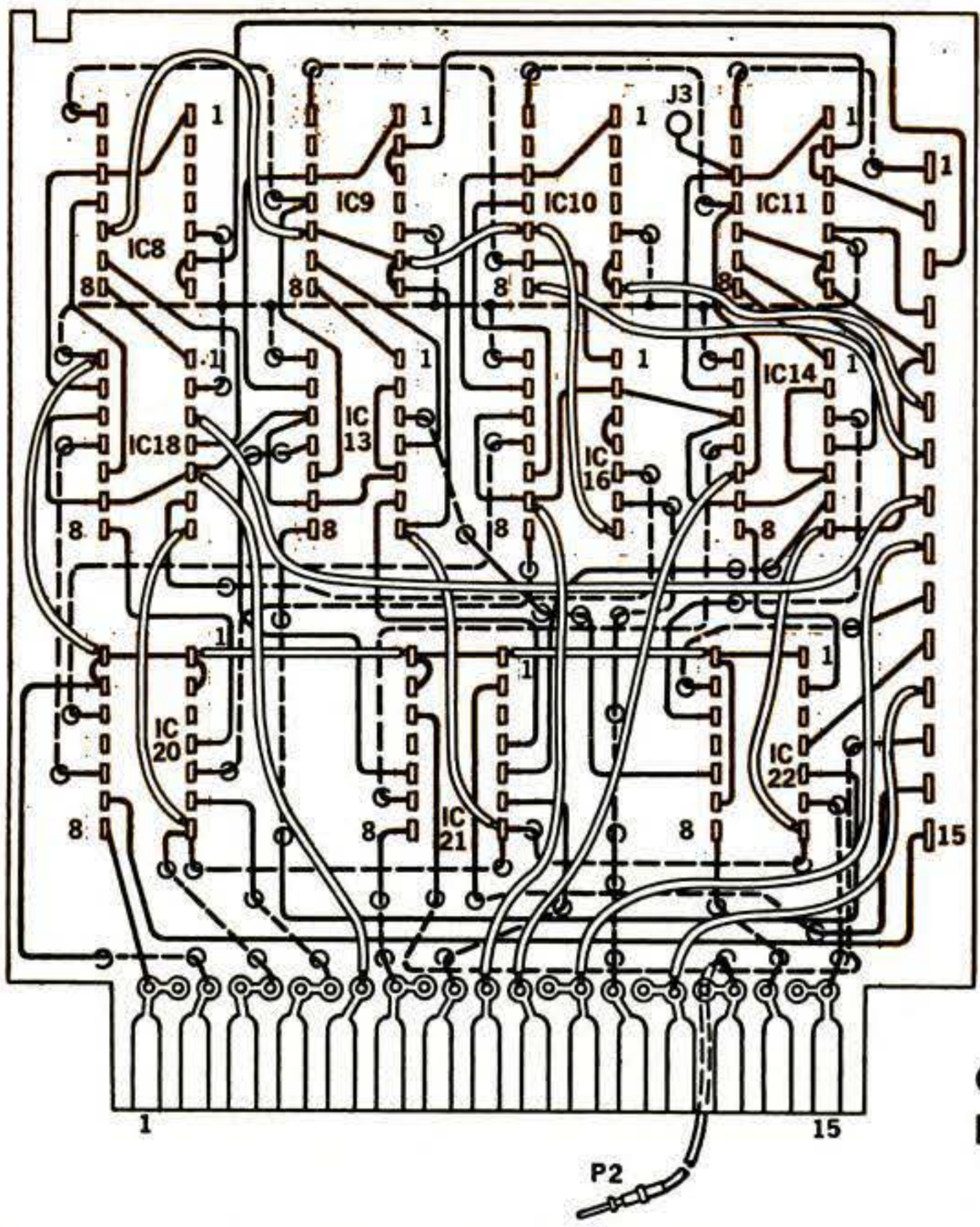
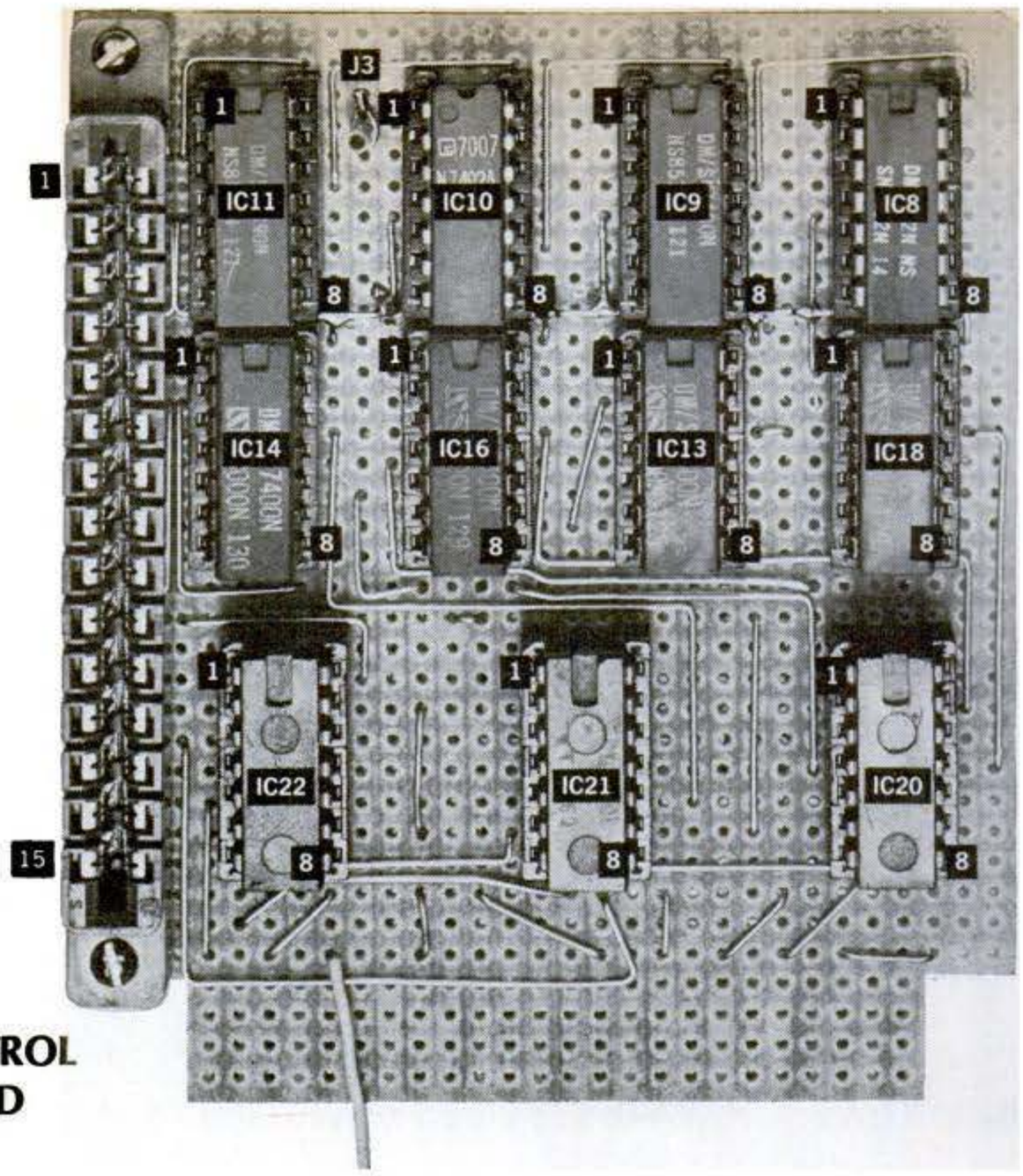
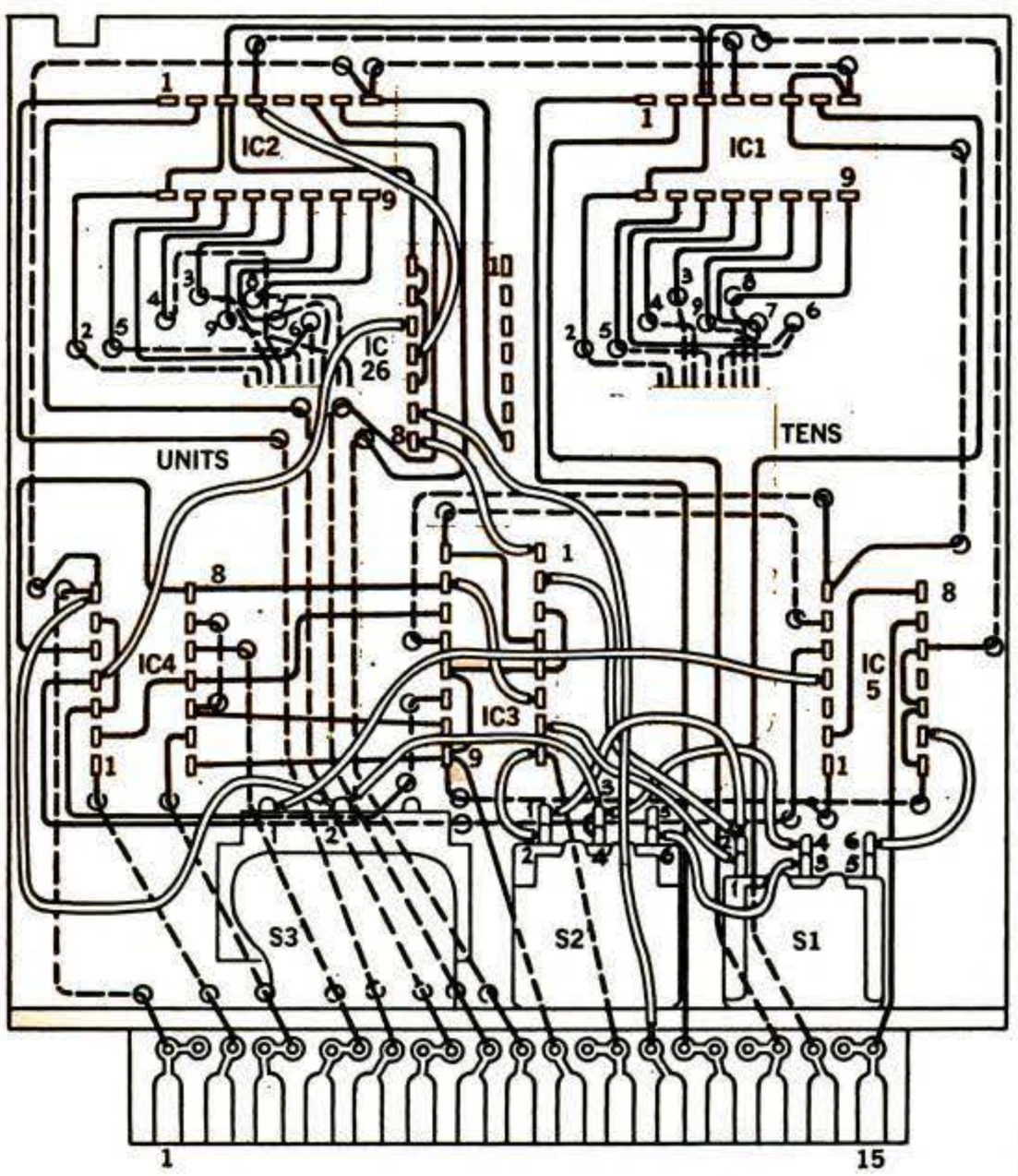
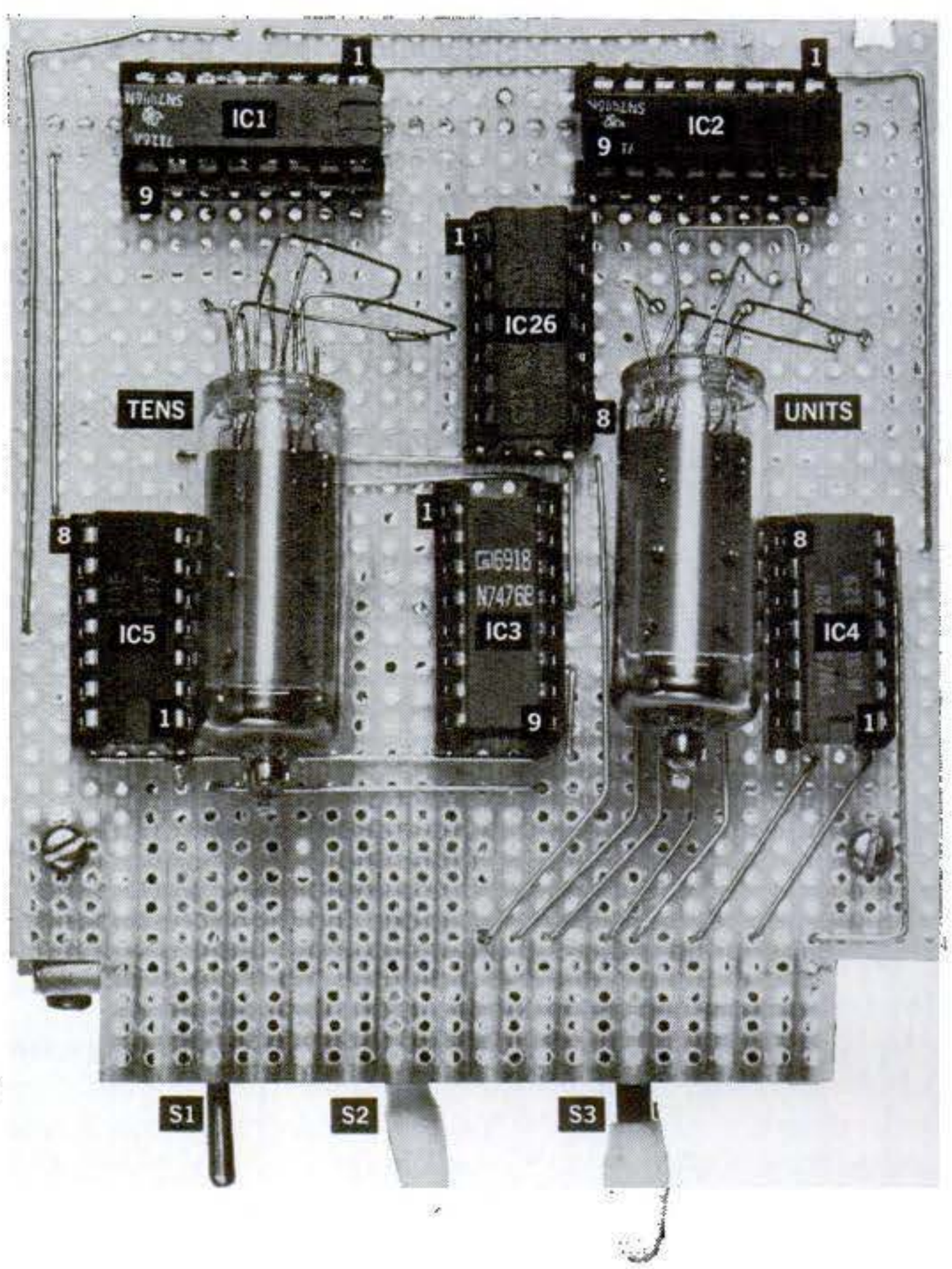




CONTROL BOARD





DISPLAY BOARD

Making time. Constructing the Time Cube is not a one-day job. Take care and don't rush. Most of the connections are just point-to-point wiring and wiring each board one at a time will keep complexity to a minimum.

Use #22 bus wire for most of the interconnections and #24 stranded wire for the exceptions shown in the drawings. Needless to say, don't let any of the bus wires touch each other to cause a short. There's a trick to back wiring to guard against this:

Unravel about three feet of bus wire at a time from the spool. Clip it off, and, using two pairs of pliers, stretch the piece approximately 1″ longer. Carefully dangle one end, preventing it from bowing or knotting, and cut off individual 6″ pieces. This gives small straight pieces of wire to work with.

Each time you must make a bend in the wire, use needle-nosed pliers to keep the bend square with no bowing on either end. Finally, bend the wire to fit the connection you're making. Don't force it in. This may mean bending and trying each wire before you actually solder it in place, but you'll be assured of a good connection with no short.

Cutting and wiring the boards. Following this order will allow you to check for proper fit as you go along: (1) base, (2) control board, (3) display board, (4) hours board, (5)

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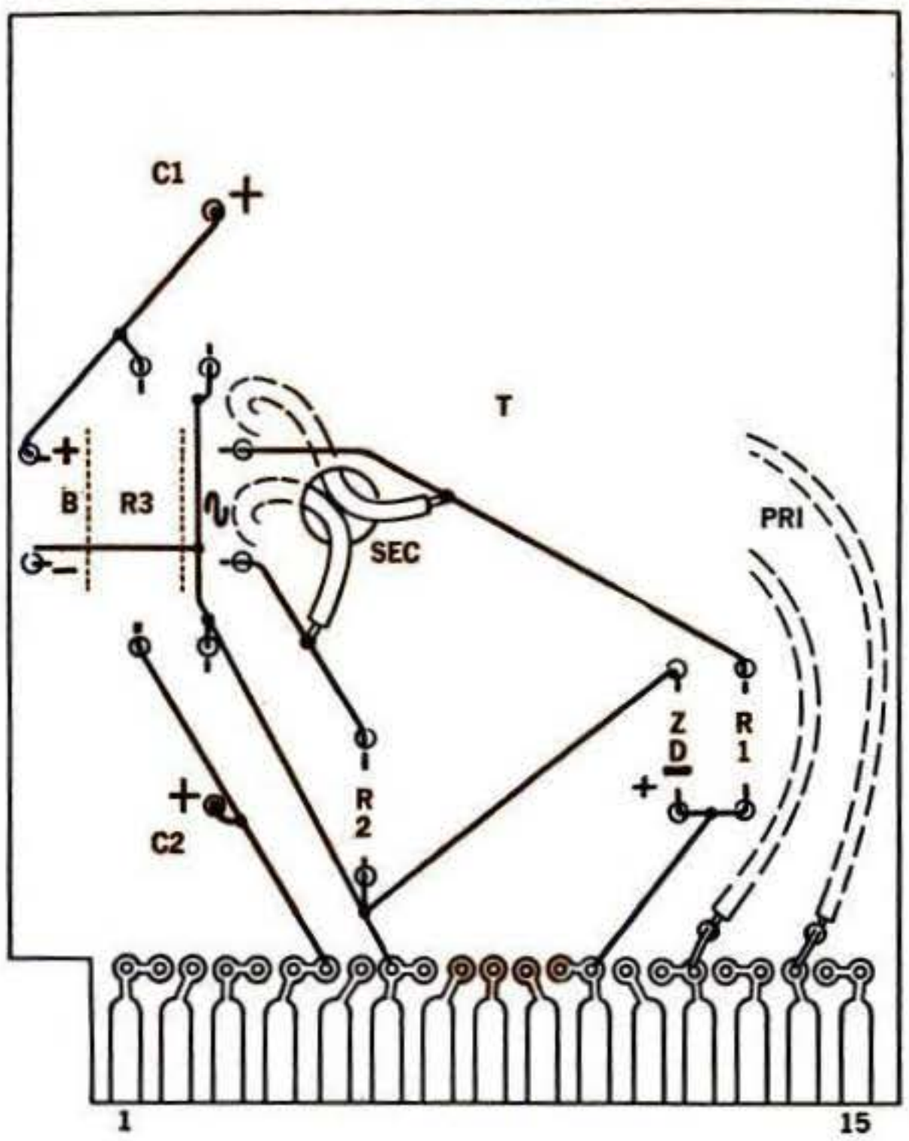
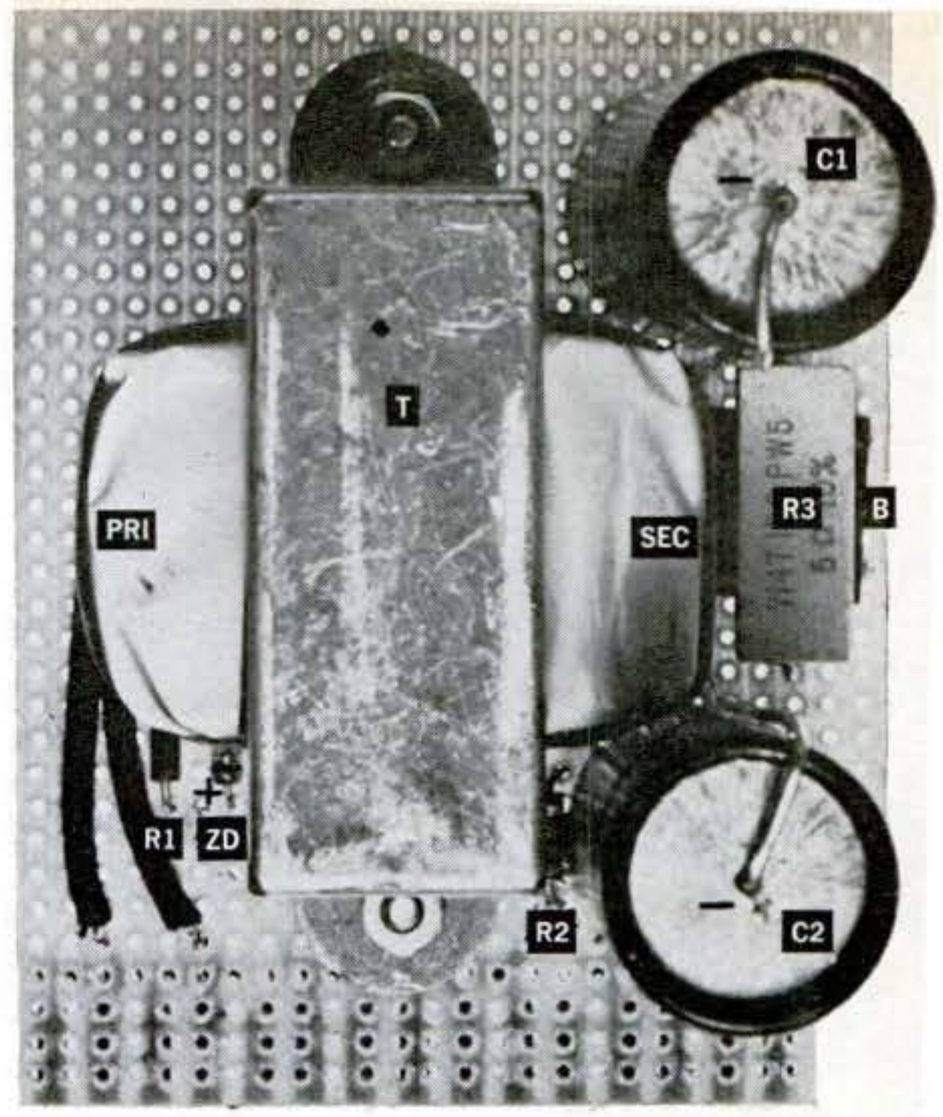
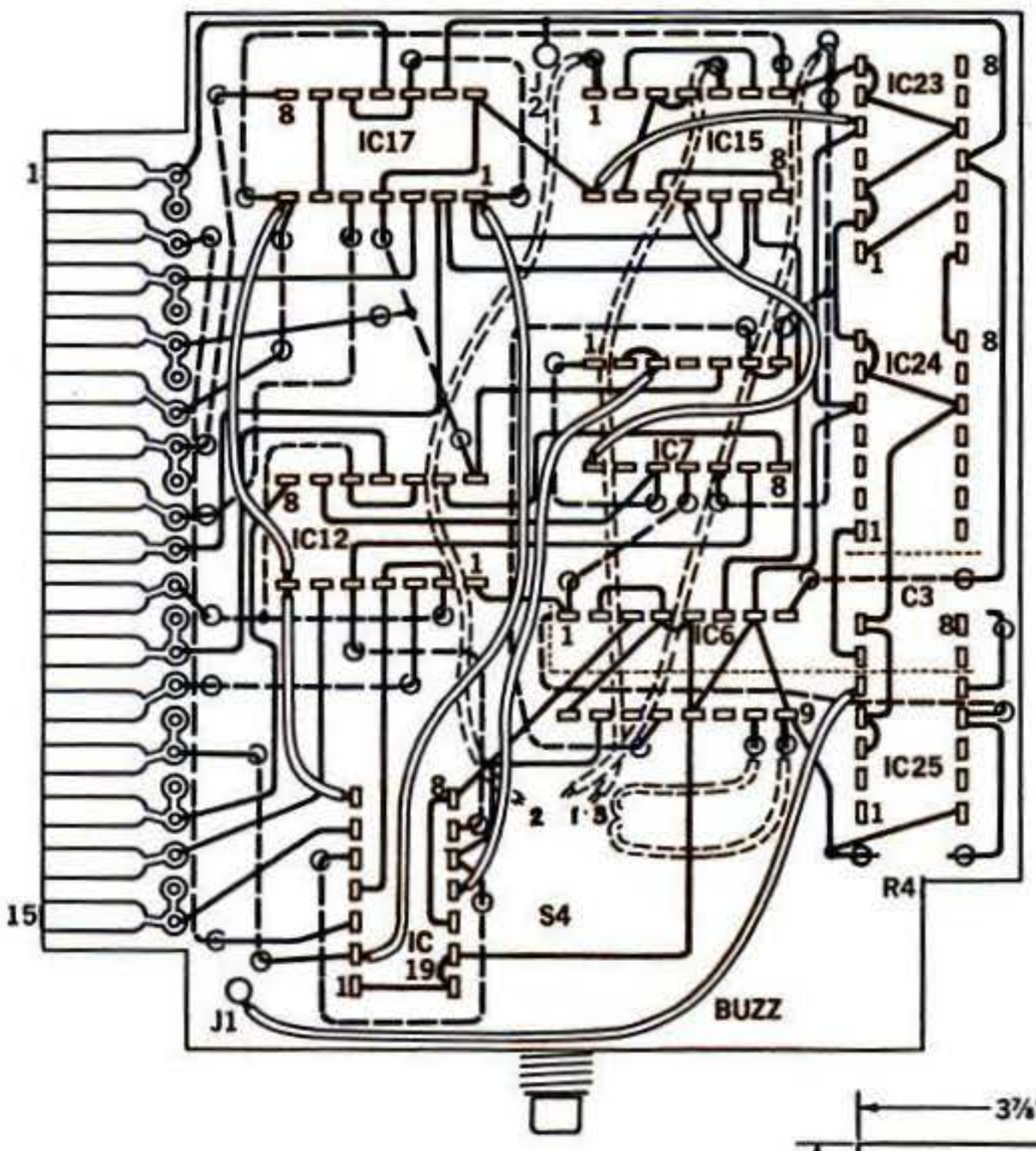
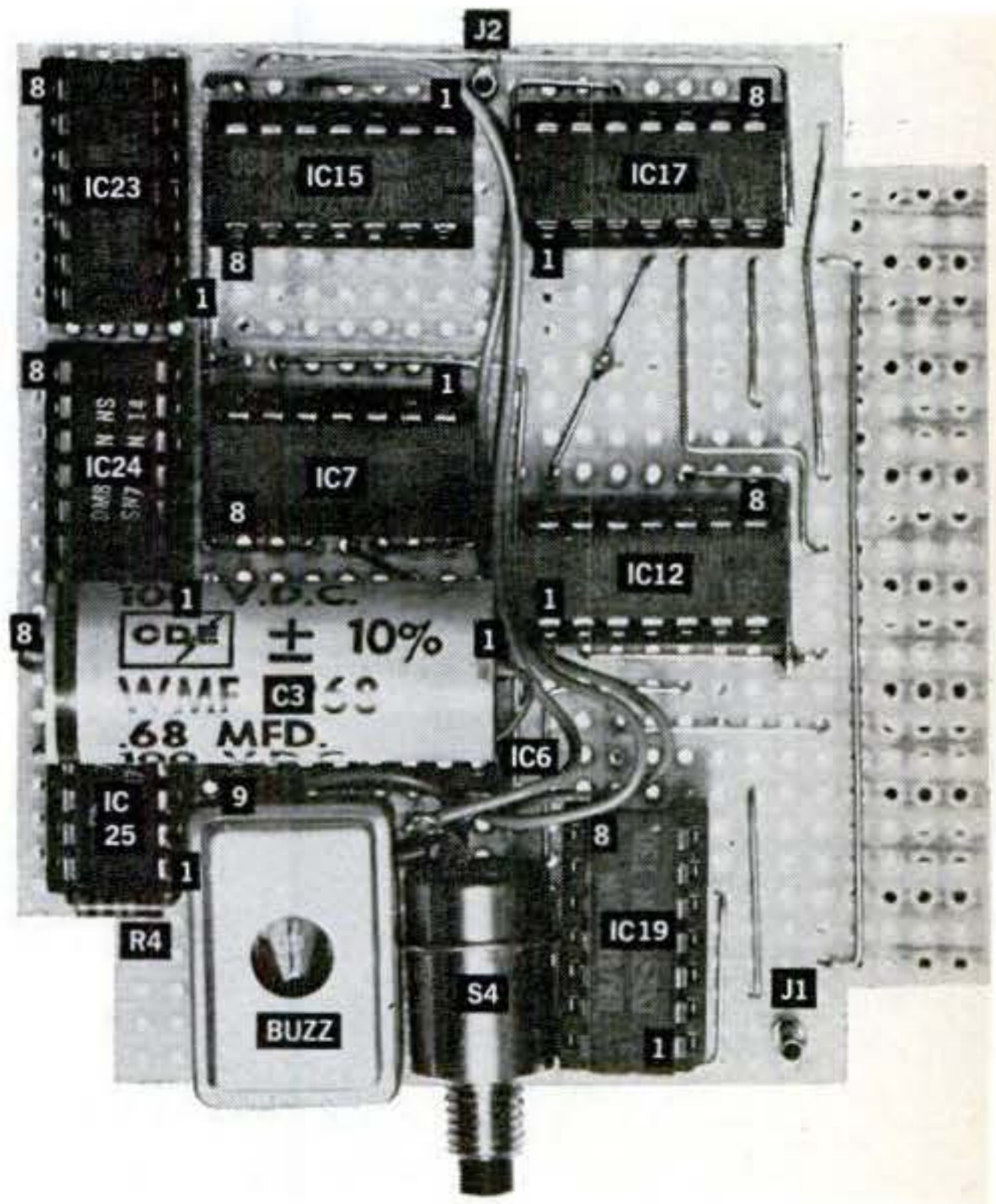


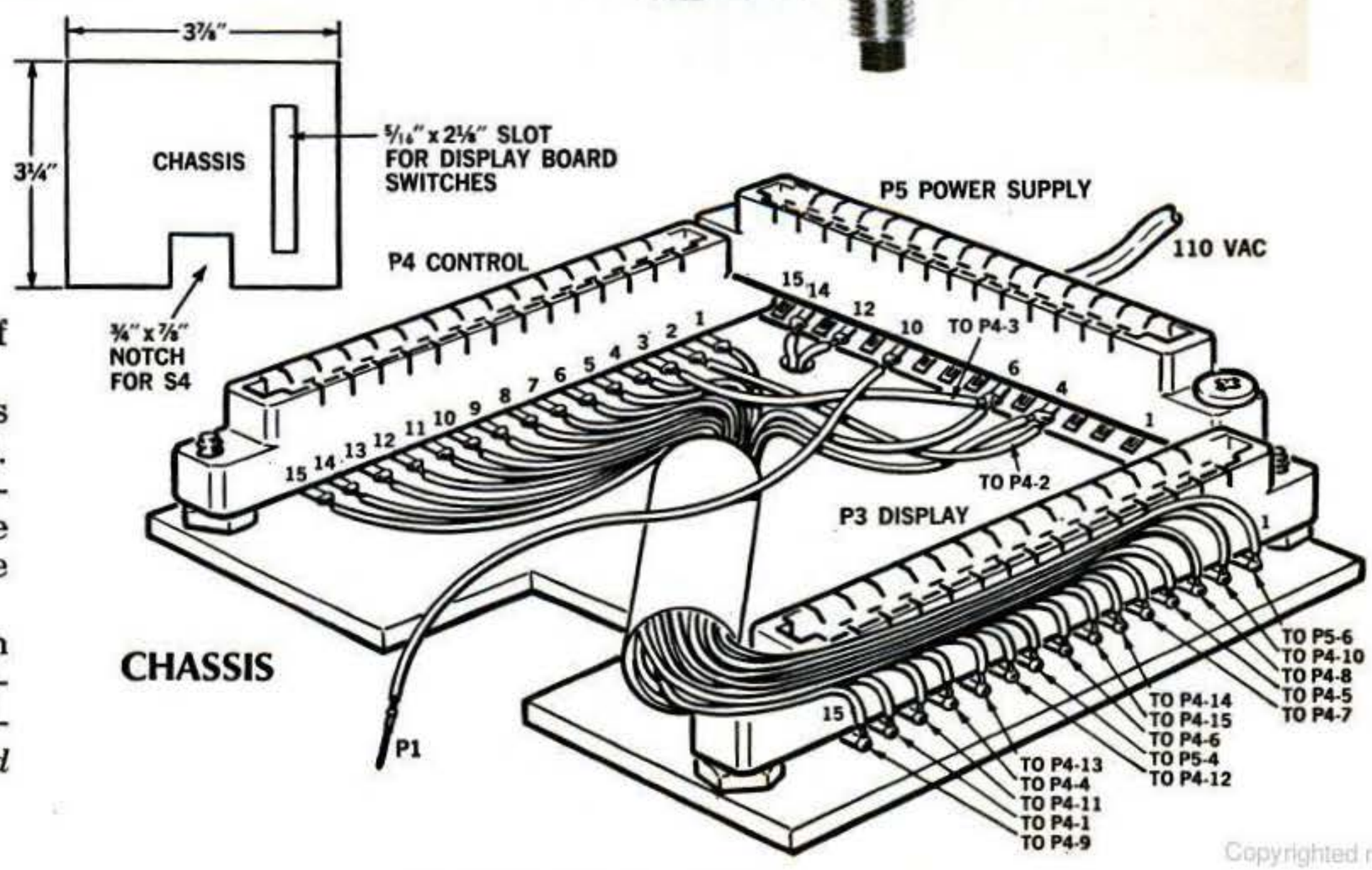


POWER BOARD





HOURS BOARD



CHASSIS

power-supply board. Make the base of anything but metal.

Each board, except the base, has hole spacing to match an IC socket. The board connectors are Quick Circuits, made by Circuit Stik, and are simply held in place by an adhesive backing.

Pushbutton switch S3 is the touch sensor for the box. Buy a long-stemmed pushbutton or use an ordi-

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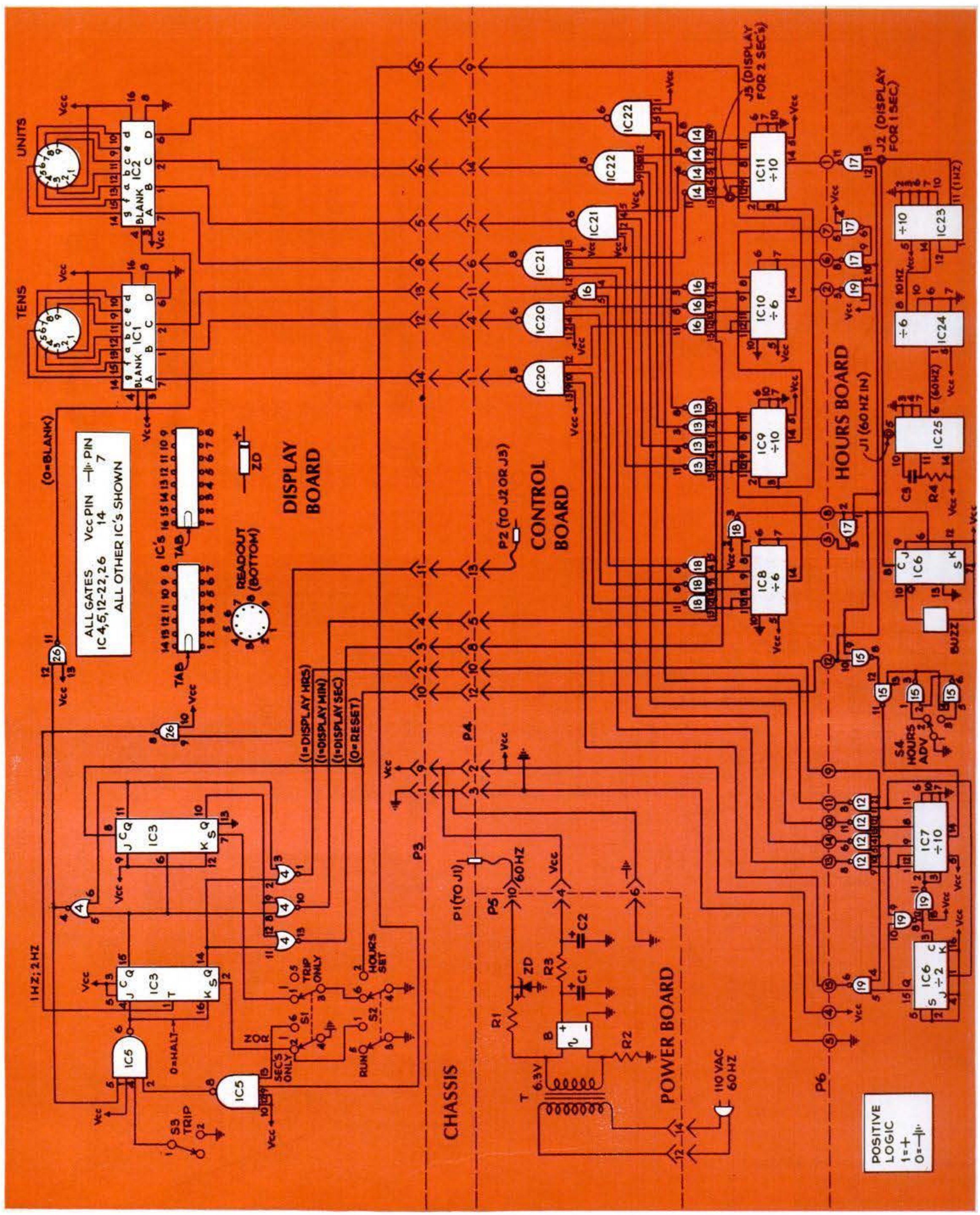

nary switch with a metal shaft epoxied to the end. Adjust its position so its button passes through the base, just touching the surface on which the clock is laid. Pushing down on the top of the clock compresses the rubber feet, allowing S3 to actuate.

Make the Plexiglas box last to insure proper fit. Cut the material just large enough to clear the clock electronics and just 1/8" short of the bottom. This will allow S3 to actuate properly.

Cost of the Time Cube. This can vary quite a bit, mainly because of the fluctuating prices of the ICs. Ours cost about $70, but we did some shopping. The ICs are made by Signetics and Texas Instruments, and you can get them easily through large chain stores, but you will pay for the convenience. Check your local electronic stores and compare prices.

[Continued on page 133]

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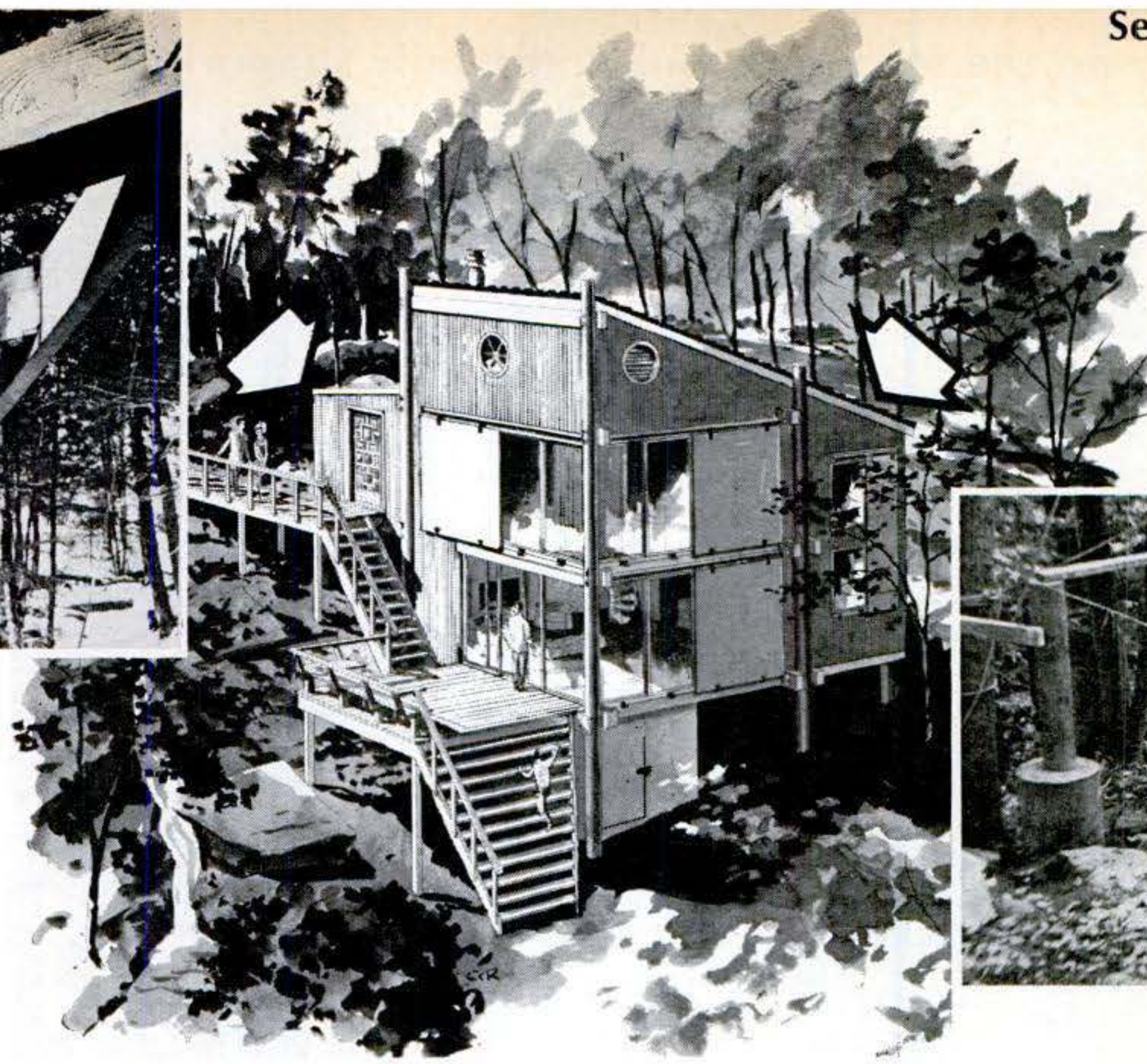


Unlike basic cube, the wings projecting beyond four support poles are of more-conventional platform framing. Entry triangle (above) perches stork-like on one leg.

The Lockbox Spreads Its Wings

Continuing the saga of our full-security house on stilts, we frame the two extensions

By AL LEES
Group Editor, Reader Activities

Last month we concentrated on the pole-and-beam cage that supports the basic 16′ cube of our Lockbox leisure home. The two wings that jut from this cube are also pole-supported, but their construction is of more conventional platform type: The kitchen walls, for example, bear the weight of the bathroom and an extension of the main roof. The other wing—a single-story projection from second-floor level—is a triangular entry that merely supports its own roof. (Both roofing systems for the Lockbox are novel and newsworthy. They'll be detailed next month.)

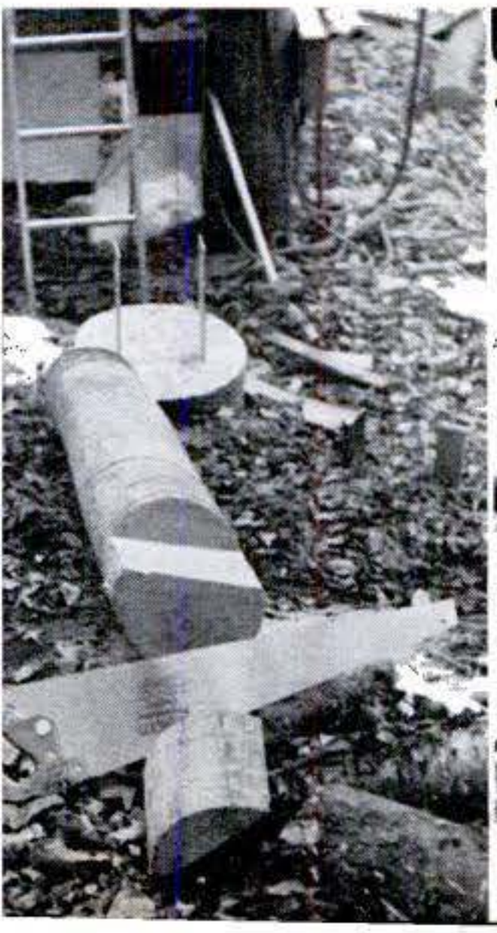
Our architect, Lester Walker, included that unique entry at our insistence. It gives character to the house, and provides a skylighted hall that's an ideal approach to our circular stair (turn page for floor plan). And that 45-degree projection serves a practical purpose as well, knifing into and dividing downhill winds that would otherwise "flat out" against this blind wall of the house.

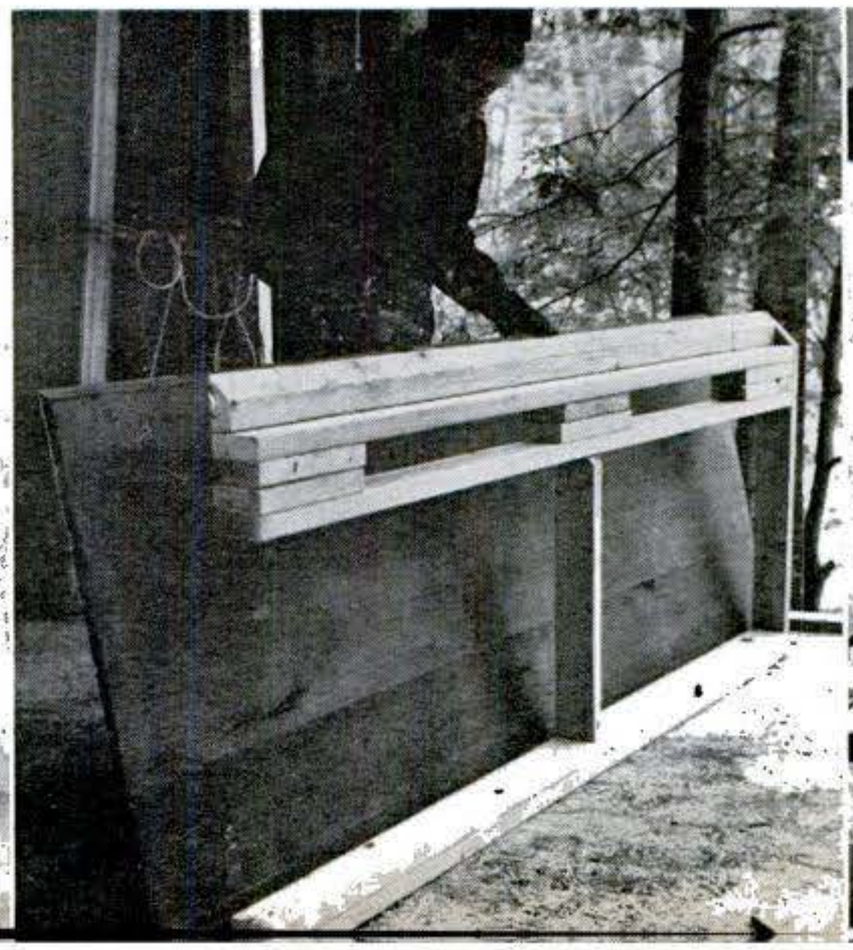
The 45-degree corner didn't prove difficult to frame, as Walker feared (photos below), and the lower top plate of both walls is securely spiked up into the bottom of the 4-by-12 attic-floor beam of the basic cage.

It was no great trick to lay out the

Continued

Entry pole is shoulder-notched at 45° to take band joists (one notch complete in left photo). Concrete footing has embedded galvanized hold-downs through which base of pole is bolted. In second photo, Lees perches on completed floor, using it for stud layout. Wall units that flank door are framed in two sections. Siding is fitted (third photo) before erection; note angle on outer stud and ply panel. Rear wall, assembled flat, is moved into place (right), notched to top plate to clear beam above.





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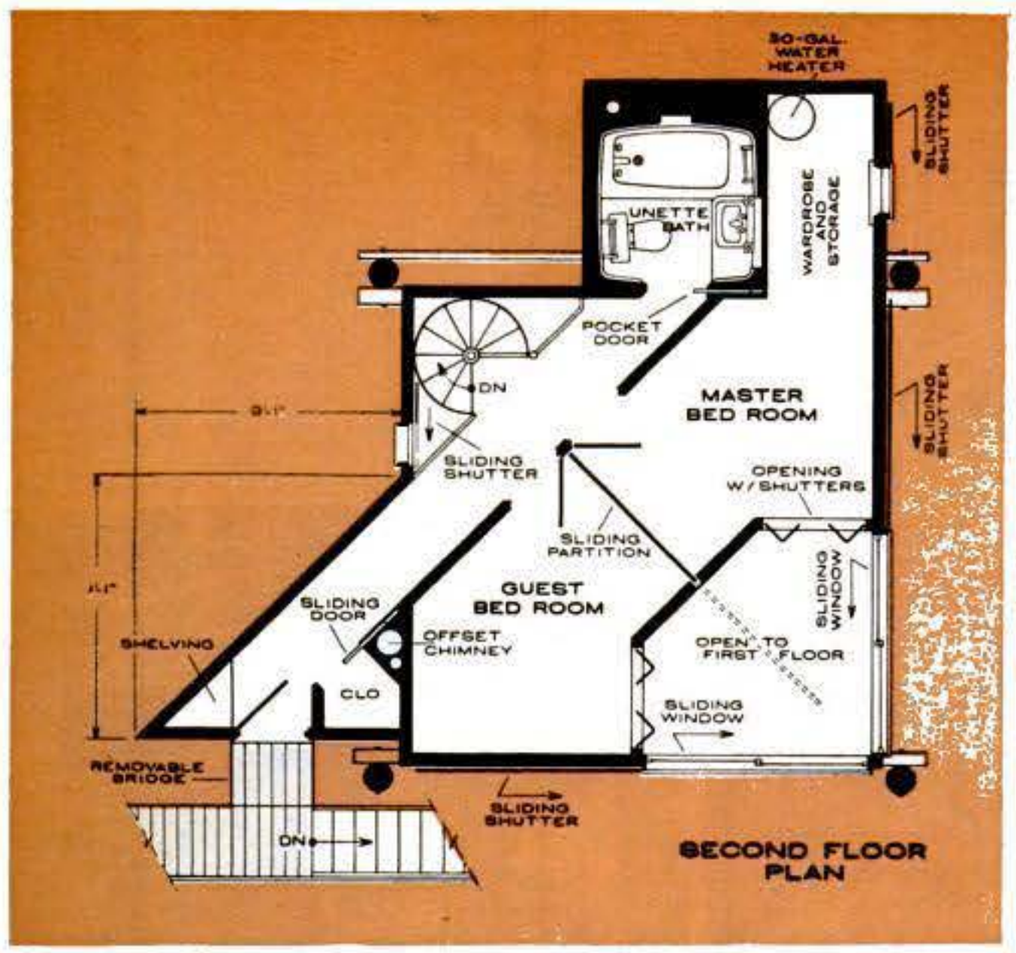
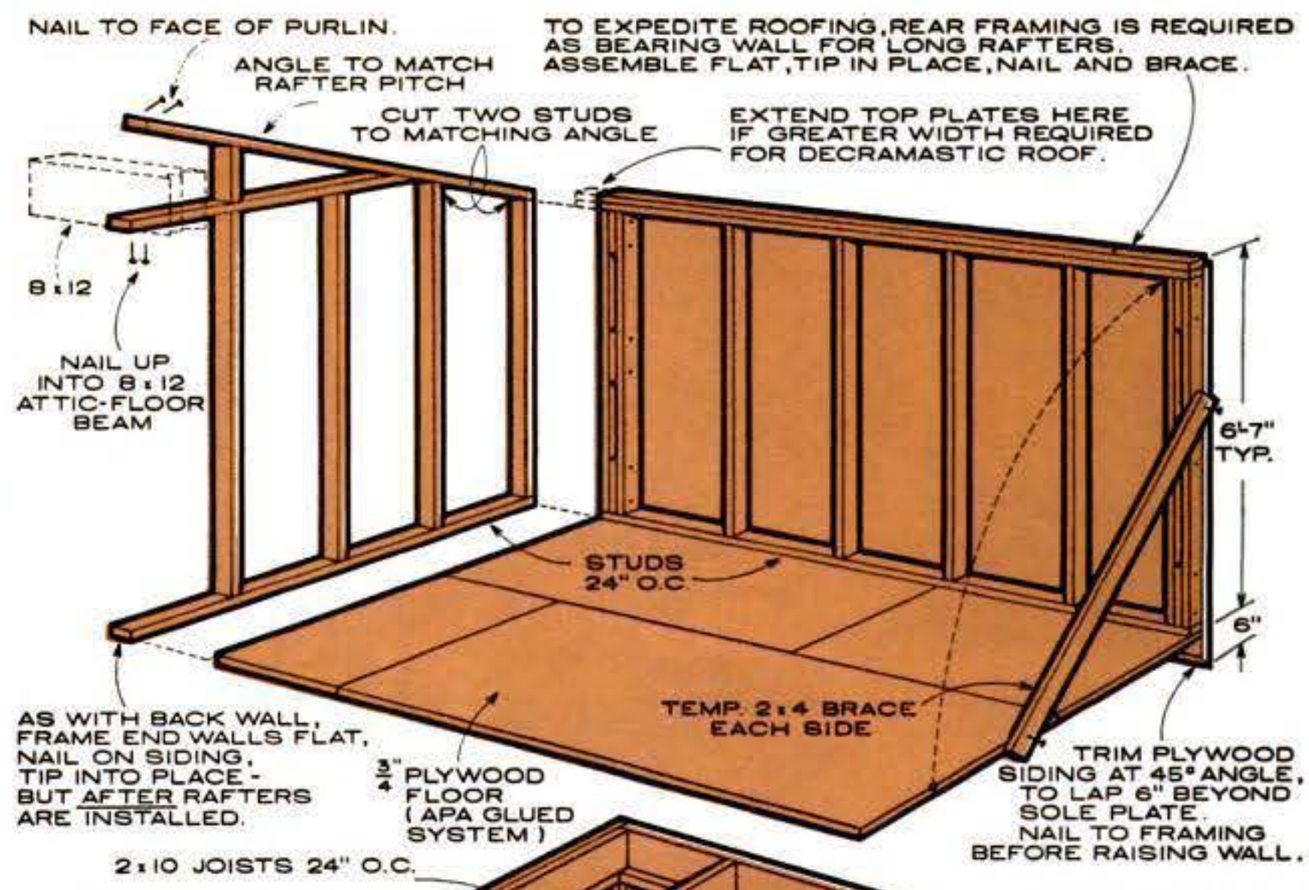
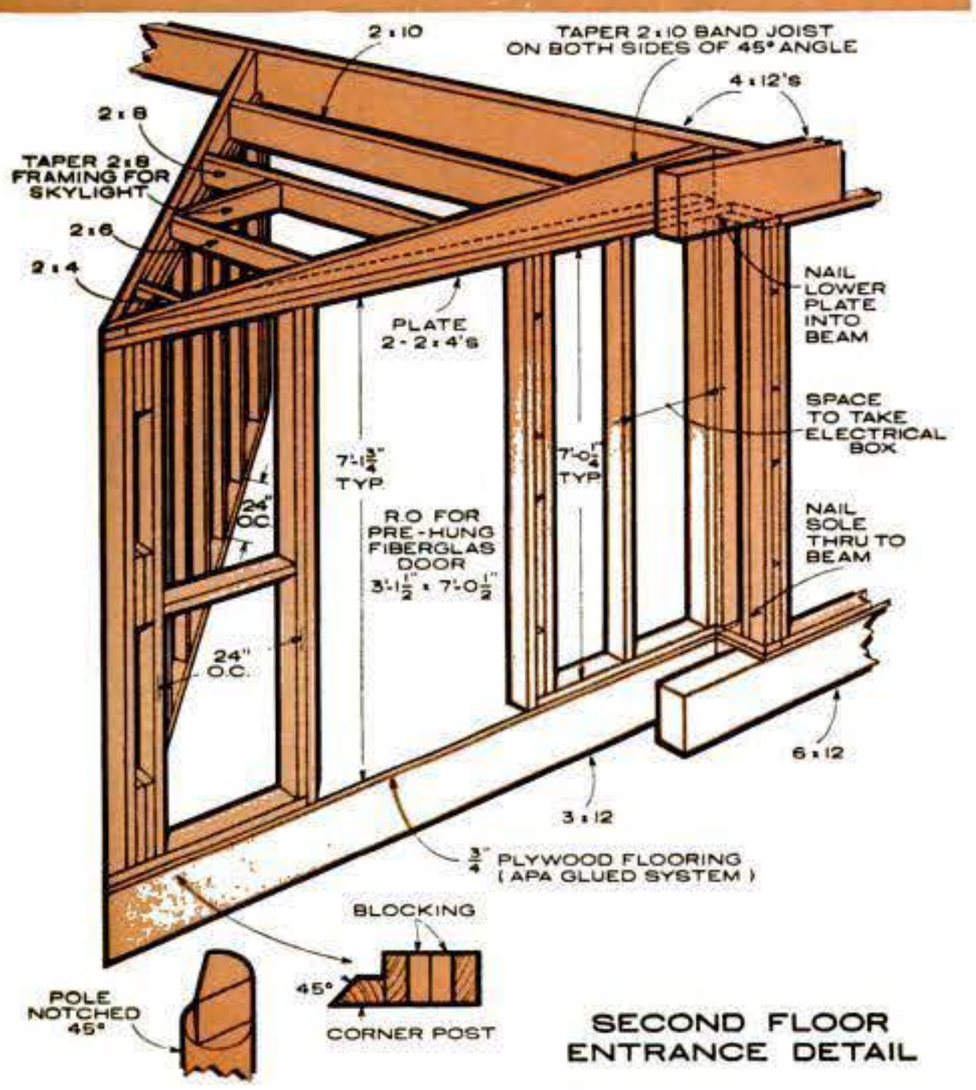
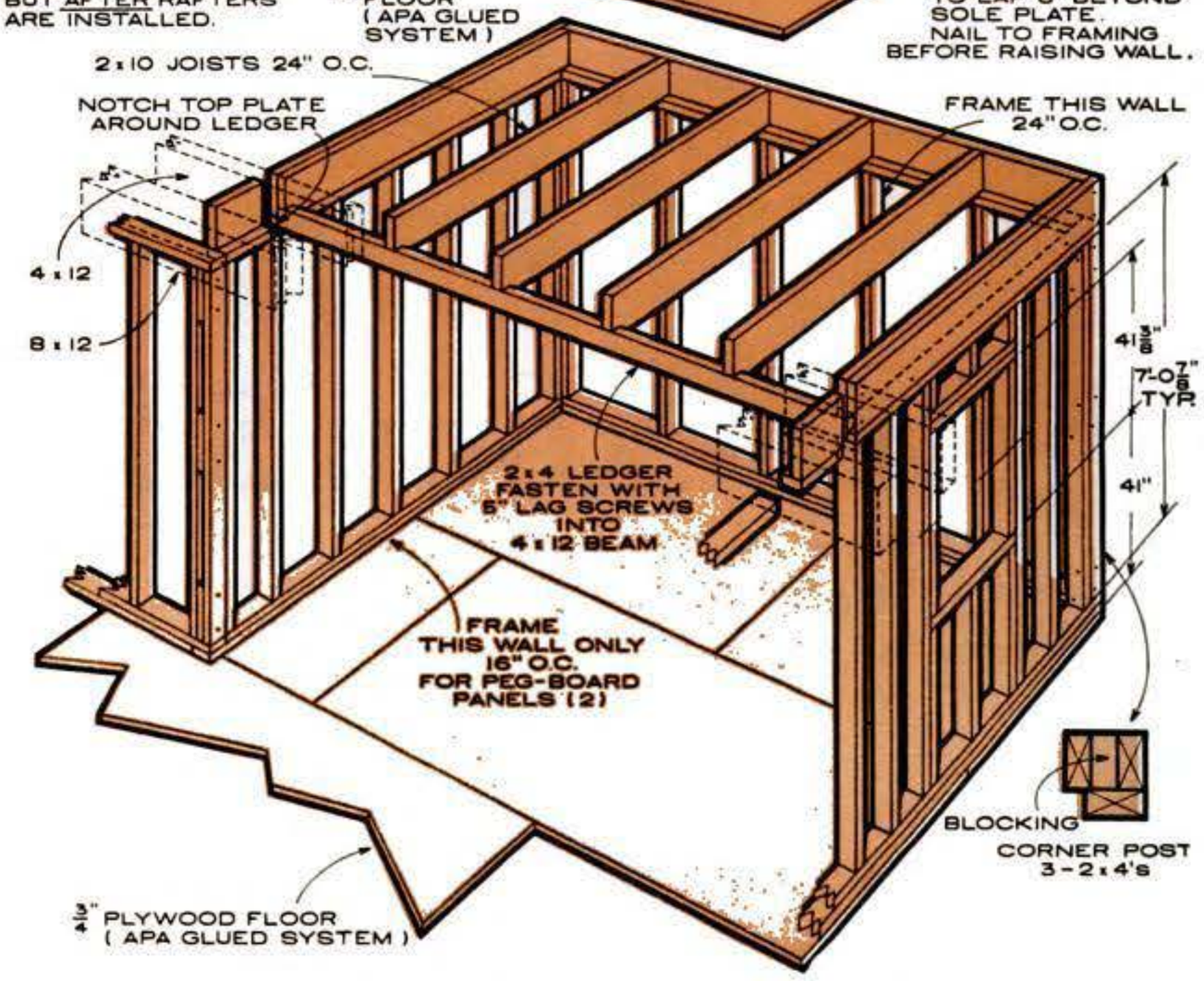
Beyond the four main poles: the only supporting walls in the house







SECOND FLOOR ENTRANCE DETAIL



KITCHEN AND BATH WING DETAIL

three additional pole holes required. On our mountain site, both wings projected toward steep slopes, so we could run out lines at proper angles to the main-cage beams, staking the far ends to the hillside at heights dictated by line-levels hooked on once the cords were taut.

The angled wall. For the wall set at 45 degrees, we simply extended the line already established by our second-floor framing of the stairwell header. Where this line intersected the line run out perpendicular to the beam, we dropped a plumb bob and dug a hole about 18″ in diameter.

Since the placement of this pole is critical (it is shoulder-notched at 45 degrees to take the 3-by-12 band joists), we left ourselves some flexibility by *not* embedding it in concrete. Instead, we poured a below-frost footing column and at the top embedded a pair of L-shaped steel-metal hold-downs with holes at the top through which—after the pole was set between them and drilled to match—we ran 3/4″ threaded rod (left over from pole-and-beam assembly). No wind will lift *that* pole!

Both the hold-downs and the pocket-type joist hangers shown in photos —including those skewed 45 degrees for the entry joists—are available from the Seidel Co., 4110 Dumbarton Rd., Houston, Tex. 77025. Write them for a complete readout of Simpson and Teco hardware for the Lockbox.

We gave the shorter poles, set at the outer corners of the kitchen/bath wing, a different treatment, as the photos on the next page show.

Saving the trees. One of the hazards of building in a forest is root damage. One of our footings had to be sunk right beside a good-size tree. Just over a foot beneath the surface, we found a network of major roots crossing the hole we had to dig for a below-frost footing. We continued digging and poured our 8″ thick footing at the bottom. When it had set, we placed several assemblies of foot-long steel pipe nipples and floor flanges (first photo, next page) on the footing, projecting up past the root bridge.

We wrapped the roots in damp burlap and filled the hole with a rich concrete mix, filling the pipes, too, as if they were lally columns. Before the mix stiffened, we embedded another nipple-and-flange unit with the flange up, centered under the pole base. A length of commercial concrete form (18″-dia. Sonotube) was set over the hole and the pour continued. The pole was positioned in the form by means of nailed-on cleats bridging the tube's rim. When the pour was complete, the braced pole was left in place until the concrete was fully set and the form could be stripped.

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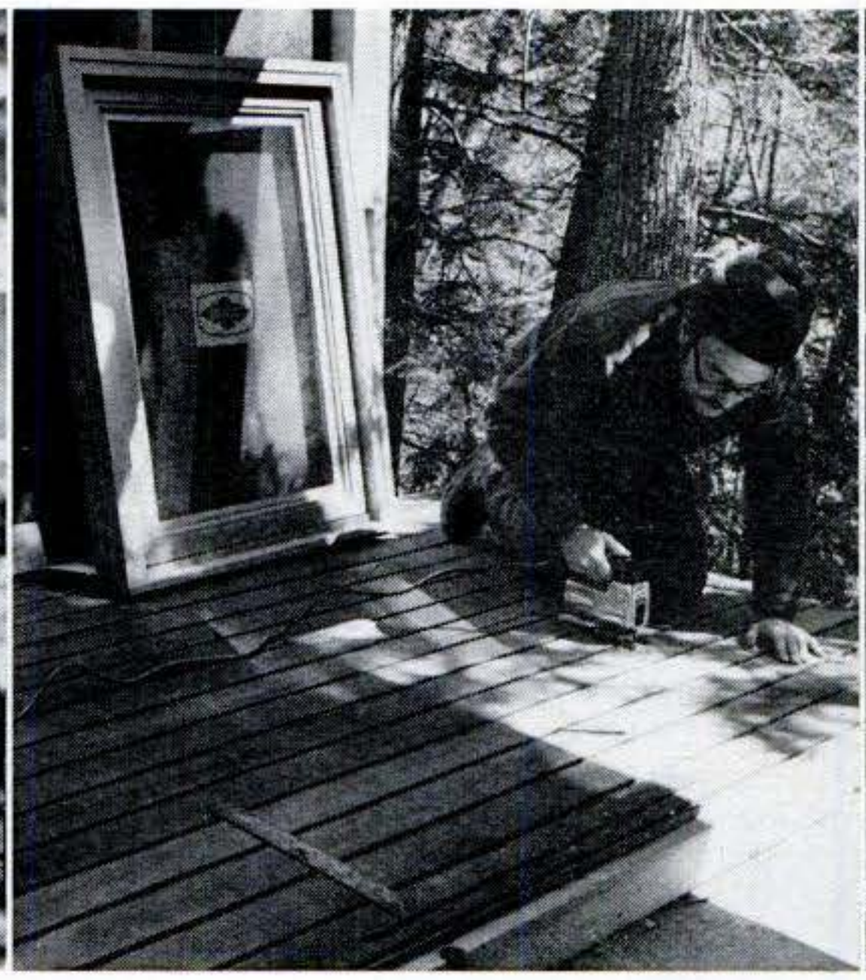
Experimental footing to save critical roots calls for 1½″ nipple-and-flange units set in concrete for base of pole to bear on.

Tubular cardboard form strips away, once concrete sets, to leave below-frost footing with pole partly embedded. Backfill firmly.

Outer doubled joist of kitchen/bath wing ties into rear beams of cage via recessed metal plate and 2x10 between 4x12 and 8x12.

For plywood floor, construction adhesive is run along top of each joist. Joists rest on top plate at back wall, this end unnotched.



End walls are framed flat and plywood siding nailed on. Here, hole is cut to match rough opening framed for top casement.

And up it goes. Siding extends 6″ beyond sill to lap joist. Bevel this bottom edge 45° for no-flashing joint with lower panel.

In our case, these footings key the rear of the house into the mountain site, letting us get by with less than the 6′ embedment recommended for the four major poles.

Study your site. Simpler footings for platform poles usually will suffice. (Prototype houses are always overbuilt. You could surely do with less than that 6-by-12 beam our plans show across the kitchen poles. But its mass weights the back of the house and ties the wing in, visually, to the basic cage.)

We recessed screw-plates (Stanley's 8″ mending plates with four #10 screws each) at each band-joist-to-basic-cage connection to humor our structural engineer, but our plywood glued-floor system (outlined last month) ties wings to cage even better. Note that the plywood floor system is used *only* in the second-floor wing sections. The floor of the main cage is to be 2-by-6 t&g planks, laid diagonally.

The rafters. Actually, you need only erect the *rear* wall of the kitchen/bath wing to provide support for the long (nearly 26′) rafters. We enclosed the entire wing to make a two-story shed to store materials and appliances as they were delivered to the site.

We applied the second-floor Texture 1-11 siding first, letting it project 6″ below the framing sole and beveling it 45 degrees toward the rear face.

The *top* edge of the panel below, then, is beveled toward the front face and a generous bead of construction sealant (such as GE's #1300) is run along this bevel before the panel is butted up under the top panel and anchored with nails angled through both bevels. Such a joint—not difficult with a portable circular saw—lets you omit obtrusive Z flashing or battens at horizontal joints.

The front wall of the triangle gave us the ideal spot to locate our entry box when we brought electricity to the structure to operate our power tools. Enclosure, here, let us apply a roof that doubles as platform access to the attic during construction, since it's sheathed in ¾″ plywood. PS

How to Order Your Plans

Architect's drawings are available, with all dimensions you'll need to duplicate our Lockbox vacation home on your own site. Send $15 (check or money order) for one set of plans—or $20 for two sets. Need extras for subcontractors—or to file for building loans or permits? Each additional set is $5 at time of original order. Write Popular Science Plans Div., 355 Lexington Ave., New York, N.Y. 10017. Ask for Plan 5547: Lockbox. Allow three weeks for delivery.

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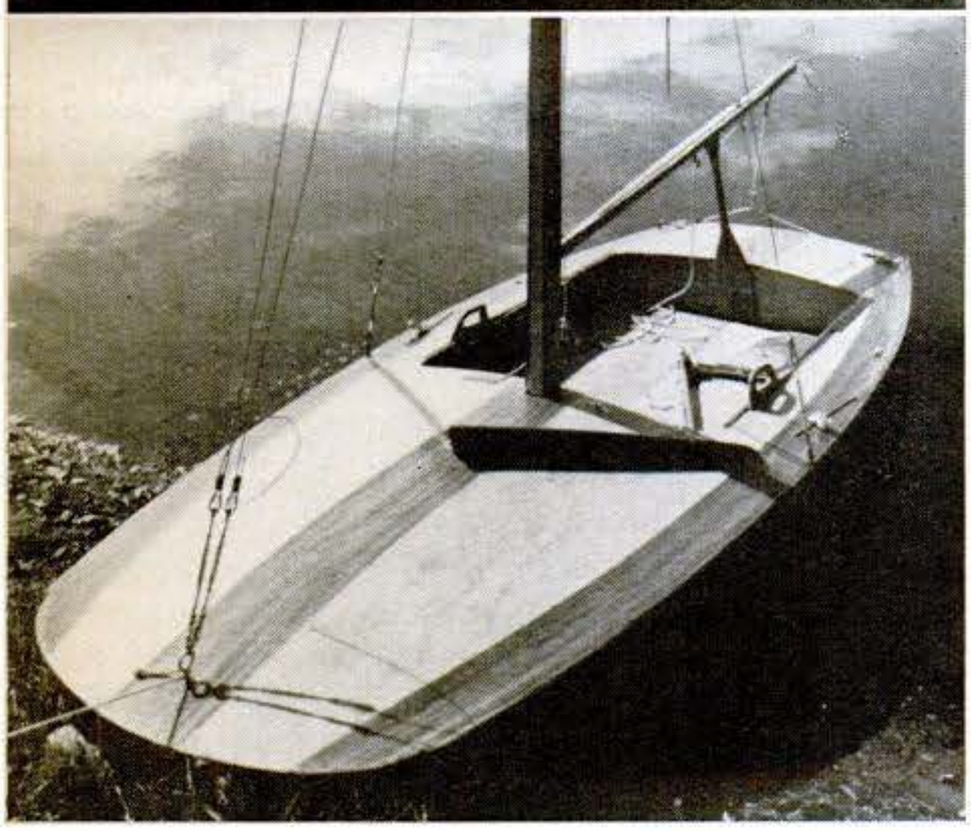
Build-It-Yourself Sailboat of New Design

Part II: How to add the deck and all the fittings, make and install your own mast and boom, and prepare your Pumpkin Seed for her first sail

By JACK PAYNE and TOM McCONAGHIE



Pumpkin Seed I underway in light air (upper photos) lies moored below. Early trials showed forestay unnecessary and it has been eliminated. In lower photo, note the boom crutch—a paddle with handle notched.

Pumpkin Seed's hull is shaped by a novel boat-building technique. Thin wood strips are laid up, one by one, around and over the hull frames. Each strip is nailed and glued in place. Then fiberglass is applied over the hull and resin applied. The result is a lightweight hull of great strength—and beauty.

Building of the 13′ scow-type hull was described in POPULAR SCIENCE last month. As the final step, it was removed from the building form and turned over on a set of cradle forms, ready for the finishing touches—and the making and installing of bilge boards, the mast, boom, sail, and all the fittings.

First of a new class? Pumpkin Seed No. 1 is introduced as the prototype for a potential new international racing class for use on lakes and sheltered bays. Builders are offered the opportunity to register their boat and to build it to temporary class rules. The class will be organized when enough boats are available.

Marconi rigged, No. 1 puts up 106 square feet of sail. Early tests found her sailing right along with other boats in the vicinity —and those who have sailed her predict that, if properly tuned and sailed, she may go right to the head of the fleet.

The boat was designed specifically for do-it-yourself building. Materials will cost about $500. The boat can be car-topped to and from the water.

Continued

Rules for proposed Pumpkin Seed class

Basic hull measurements

Length must be at least 155″ (393.7cm), not more than 157″ (398.8cm).

Beam must be at least 62″ (157.5cm) and not wider than 63½″ (158.7cm).

Each hull station must conform to standard PS class templates within ⅛″ (3.18mm).

The hull may be constructed of any material but must weigh at least 190 lbs. (86.182kg.) with bilge boards and hull hardware in place.

The mast must be located directly ahead of frame No. 3, not more than 68½″ (173.7cm) from the bow.

Chain plates are to be 10″ (25.4cm) astern of the No. 3 frame.

Mast and boom measurements

The mast must be at least 19′ 4″ (589.3cm) heel to top and made from wood. Sail track must be used from the gooseneck to sheave at top.

The mast with rigging attached (except gooseneck and boom) must weigh at least 25 lbs. (12.33kg).

The boom must be solid (T shaped) and carry a sail track from 12″ (30.5cm) aft of the gooseneck end to the aft end of the boom.

Rudder and bilge boards

The rudder must be of the size and shape shown on the official plan. It need not be of kickup design.

The bilge boards must be 11½″ (29cm) wide and 45″ (114.3cm) long and may be either ¾″ plywood or ¾″ redwood and must not be weighted.

Note: The above is just a guide for home builders. For complete tentative rules and regulations for the proposed class, send a $3 check or money order (no stamps, please) to International Pumpkin Seed Class Assn., Box 301, Franklin Lakes, N.J. 07417.

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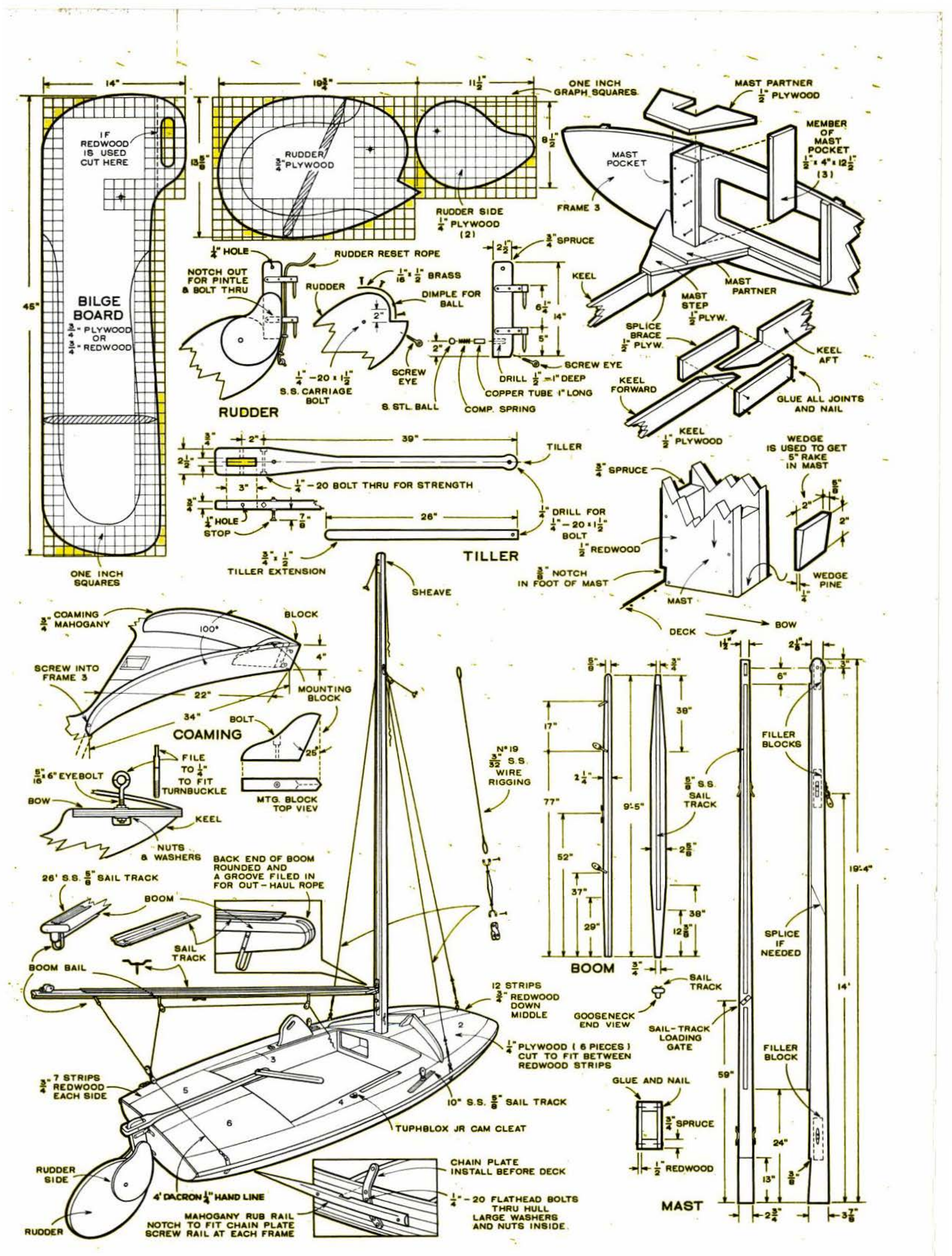

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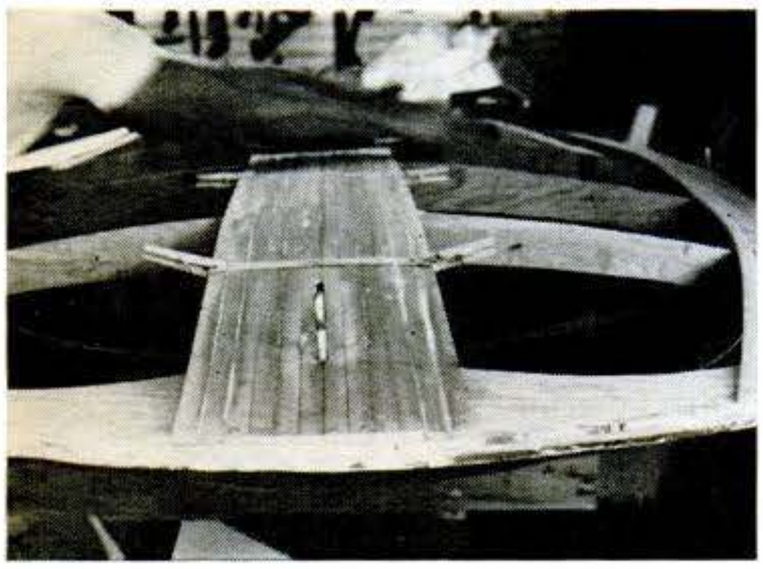
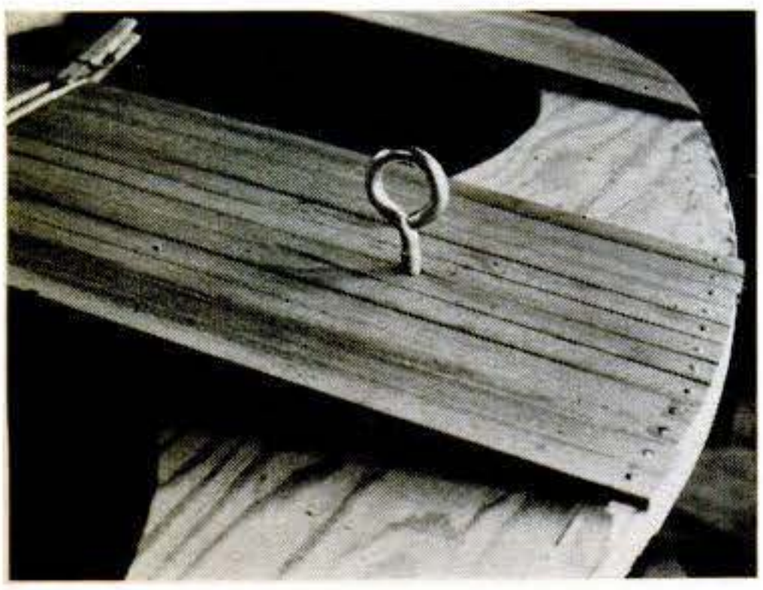
Applying the deck. The deck can be sheet plywood, redwood strips, or a combination of both—which we chose. We put seven strips on each side and 12 down the center, six on each side of the centerline. The redwood strips were glued at all contact points and nailed. Brass or copper nails improve appearance. Plywood was cut to fit between the redwood. But do not put it on until the chain plates, bilge boards, and other deck fittings are installed.

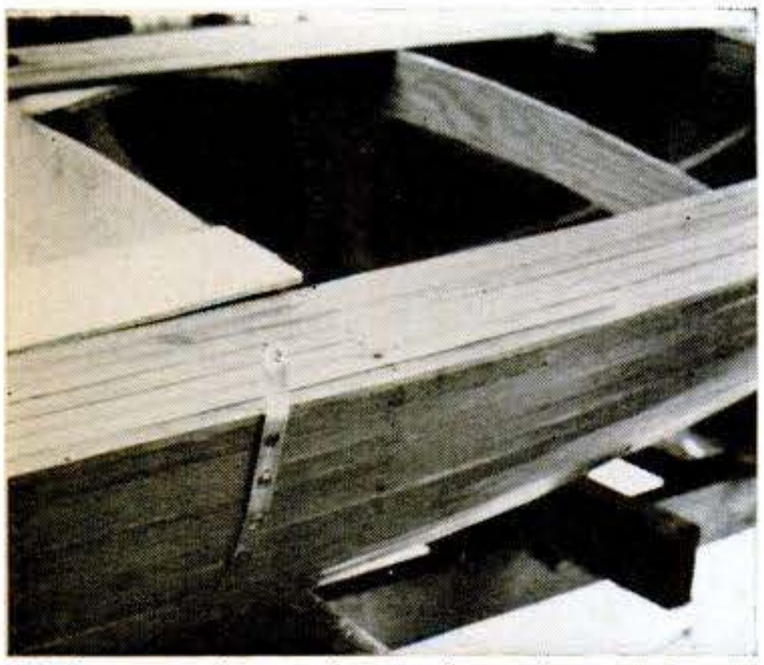


Redwood deck strips were held together by heavy rubber bands until glue had set. Spring-type clothespins held the bands.



Big eyebolt at bow should go into place before the deck has been installed. Put resin on the nuts and threads underneath.

Plywood is fitted between redwood strips on Pumpkin Seed, as seen here. Note also bilge-board trunks and glove compartment.



Fittings such as chain plate should be in place before deck is finally closed in. Entire deck could be plywood if you wish.

Bilge boards can be made of ¾″ plywood or ¾″ redwood. Redwood is lighter and easier to work. If your choice is plywood, use marine grade —or make certain there are no voids in the core. Trace the bilge boards from the pattern and cut out the handles as indicated. If redwood is used, cut and trace the pattern shown and attach handles at the top.

Drill a ¾″ hole through the bilge boards where marked and press in a bronze or brass bushing for the pivot bolt. Use a ½″ plated carriage bolt 3″ long for the pivot. Shape the boards below the waterline as shown; finish with varnish or resin.

The rudder. Its outline must conform to the template and it must be of ¾″ plywood. However, it doesn't have to be of kickup design. It can be one piece for less resistance when sailing. But the kickup is best if you should want to beach the boat.

Most deck fittings are attached with nuts and bolts. After they are in place, put resin on and around the nuts under the deck. Apply one coat of resin when fiberglassing the cockpit floor and sides. Two make the floor slippery.

Rub rails and cockpit coaming. These are of mahogany. Notch the rails for the chain plates and screw the rails to each frame. Taper them at the bow to form a smooth contour. Make the coaming from two ¾″-by-4″-by-34″ mahogany pieces. Trace the hull contour on the bottom of each piece. Set your saber saw at 25 degrees and cut on this line. Cut the center at about 50 degrees where the two boards meet. This takes a little trial and cut to get proper fit.

Make a mounting block for the center and bolt it to the deck. Then fasten on the coaming pieces. Screw them to the mounted block and to frame 3 through the deck. Finish all trim with resin. Flow resin on heavily between deck and coaming.

Making the mast. It's the box type, built up from two sides of redwood and a front and rear spruce strip, all glued and nailed together. Where fittings are needed, attach filler blocks. If ½″ redwood 20′ long isn't available, splice the side pieces as indicated on the plan. The same goes for the spruce strips. But don't splice the sides, front, and back at the same place. Stagger the splices.

First lay out the two redwood side pieces. Make sure you allow for setback at the bottom to the sail-track side of the mast. This is for the rake.

Using Weldwood waterproof glue, glue and nail the front and rear strips to one side. Mark where fittings will go and shape filler pieces for these points. After gluing and nailing in the fillers, put on the second side. Round off and sand corners. Finish with two coats of spar varnish.

Making the boom. Use spruce—Sitka, if possible. Shape the top and bottom pieces with a saber saw and plane. Glue and nail these together to form a T. When the glue has set, sand the boom smooth and finish with two coats of spar varnish.

We cut all our spruce pieces from a 2″-by-9″-by-13′ (actual dimension) Sitka-spruce plank that our lumberyard had on hand to sell for scaffolding. The yard ripped it for us.

In adding the hardware to mast and boom, make sure the sail track is straight without snags.

The sails. Ours were made from our plan by Alan-Clarke Co., Northport, N.Y. Any sailmaker can make them, but must make them to class specifications. To comply with the rules the sailmaker must send to International Pumpkin Seed Class Association for sail labels. Sails should cost about $140 for both the mainsail (with your number on it) and the jib.

When builders send to the association for a registration number, they will receive, in addition, sailmaker's instructions for forwarding to the sailmaker of their choice. PS

How to order building plans and templates

Large-size plans and exact-size cardboard templates are available for frames, bow, transom, and other parts to help you build Pumpkin Seed. Plans include details it was not possible to present in the magazine; also a full materials list. Plans cost $10, templates another $10. Send check or money order with a note to Popular Science Plans Div., 355 Lexington Ave., New York, N.Y. 10017, asking for Plans 5545 or Templates 5551. Allow three weeks for delivery.

Register your boat by sending a $10 check or money order to International Pumpkin Seed Class Assn., Box 301, Franklin Lakes, N. J. 07417. You will receive a brass hull plate with your number, builder's name, and date built stamped on it. You will also receive complete sailmaker's instructions and tentative rules and regulations for the class. Your name will be placed on the mailing list to receive further class information as it develops.

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Kings and Super Kings: 19 mg. "tar," 1.3 mg. nicotine av. per cigarette, FTC Report (Aug. '71).

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Taking Care of Your Car

Good hints others have used

Got a car tip? We pay $25 for each one accepted. Send it to Car Care, Popular Science, 355 Lexington Ave., New York, N.Y. 10017. None are returnable.

Cleaning your car? When you reach the instrument panel, if it's vinyl covered, use only a cleaning agent with a nonalkaline base. The same goes for all vinyl trim. An alkaline cleaner can discolor vinyl—especially a dark-colored vinyl.

When cleaning a brake main cylinder or any wheel-cylinder part, always use denatured alcohol or brake fluid. Never use solvents such as gasoline, kerosene, acetone, or paint thinner—they deteriorate rubber parts, causing them to become soft and swollen.

If your car's smog controls include an air injection pump—don't lubricate it. It's permanently lubricated. That hole you see is for venting. When steam-cleaning the engine, mask the hole and fan to prevent liquids from entering the pump.

Bezel nuts that hold controls to the instrument panel can be removed without a special wrench. Drive two 1" finishing nails into a piece of wood. Space the nails the width of the nut. Let them protrude just enough to insert in the nut.

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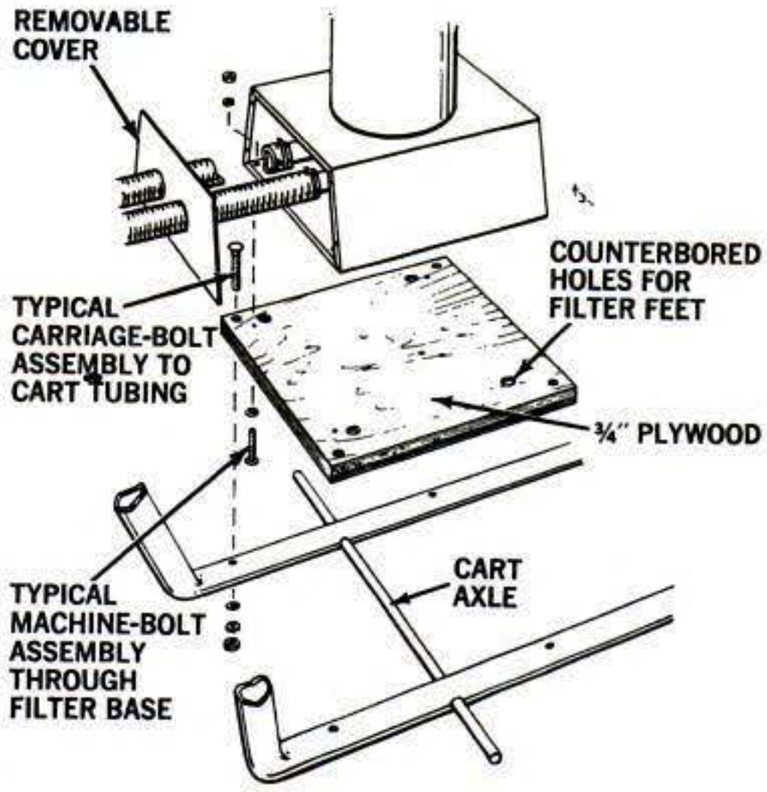
On the finished unit shown, the power cord is used to casually lash the hoses to the cart. A net or cloth basket can be rigged behind the filter for pool toys, dipper, chlorine dispenser, and any other accessories you have.—*Frank M. Butrick*



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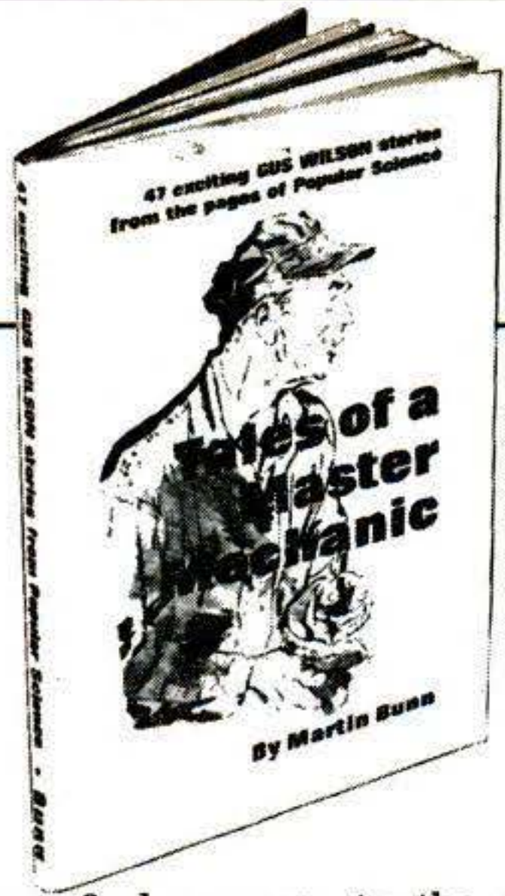

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1. In the army, when you wanted to keep someone from making off with your Jeep, you switched the cables of cylinders one and four, either at the plugs or distributor. "The engine will start and idle," Gus explained. "But those two cylinders are firing on the intake stroke, and deliver no power. A four-cylinder engine will quit if you try to load it."

2. Gus found that another mechanic, in checking a nonfunctioning oil-warning light, had pulled out "the generator warning light by mistake, then short-circuited its leads when he pushed it back in. That short let current flow from the alternator through the fuel-gauge circuit, around Robin Hood's barn, to the ignition coil. The alternator puts out juice even at idle, so it kept the ignition working after you switched off the normal circuit, and you couldn't stop the engine."

3. The symptom was a repetitive squeak from one wheel when the brakes were applied. The squeak came from a deformed brake drum. This resulted from overtightening the lugs — in the wrong sequence.

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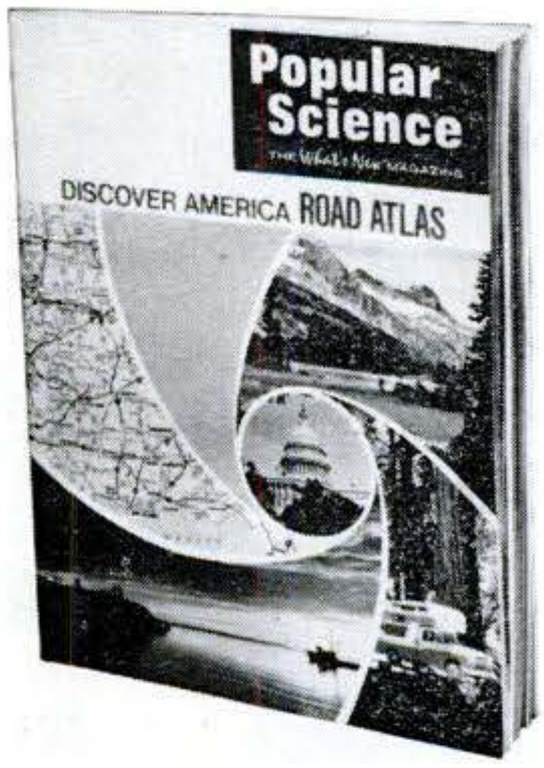

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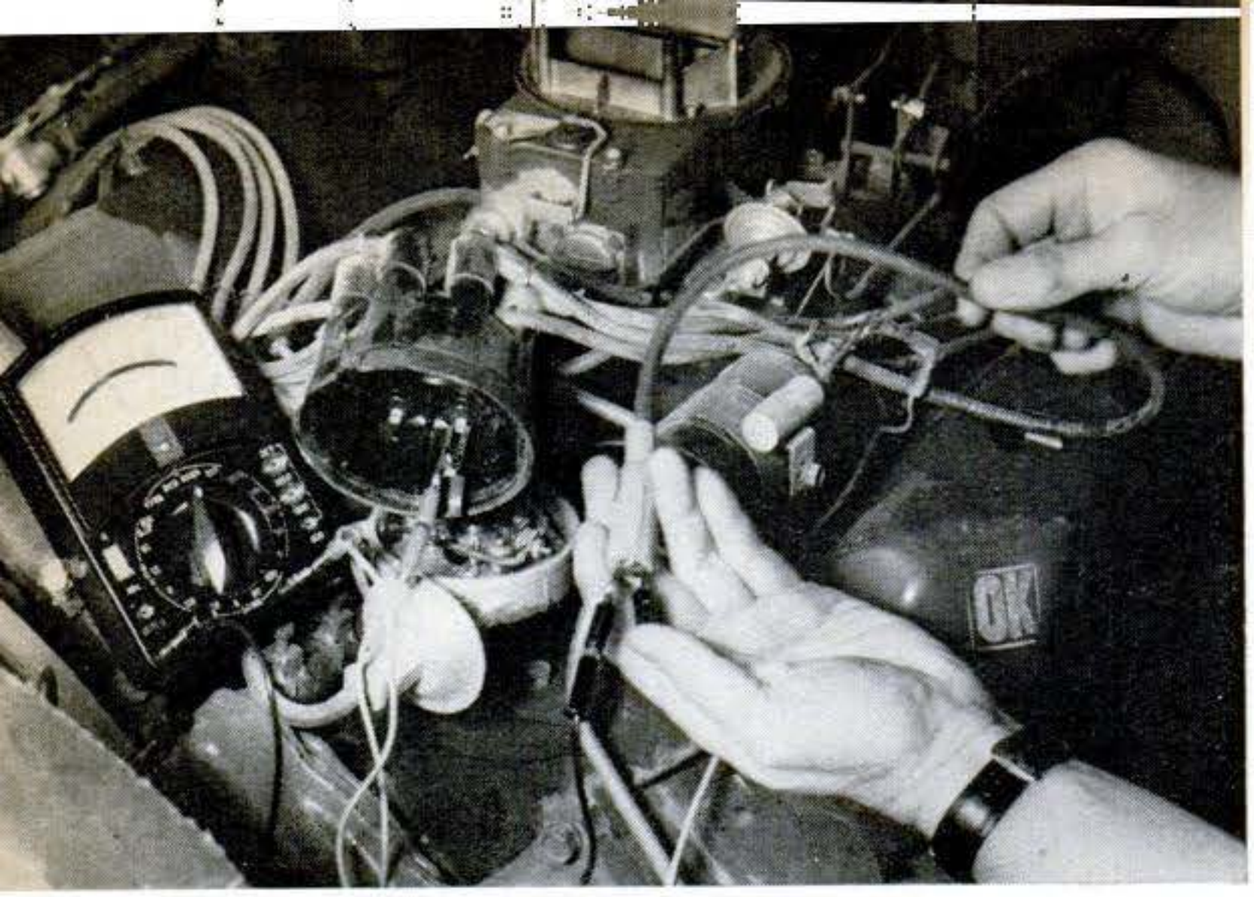
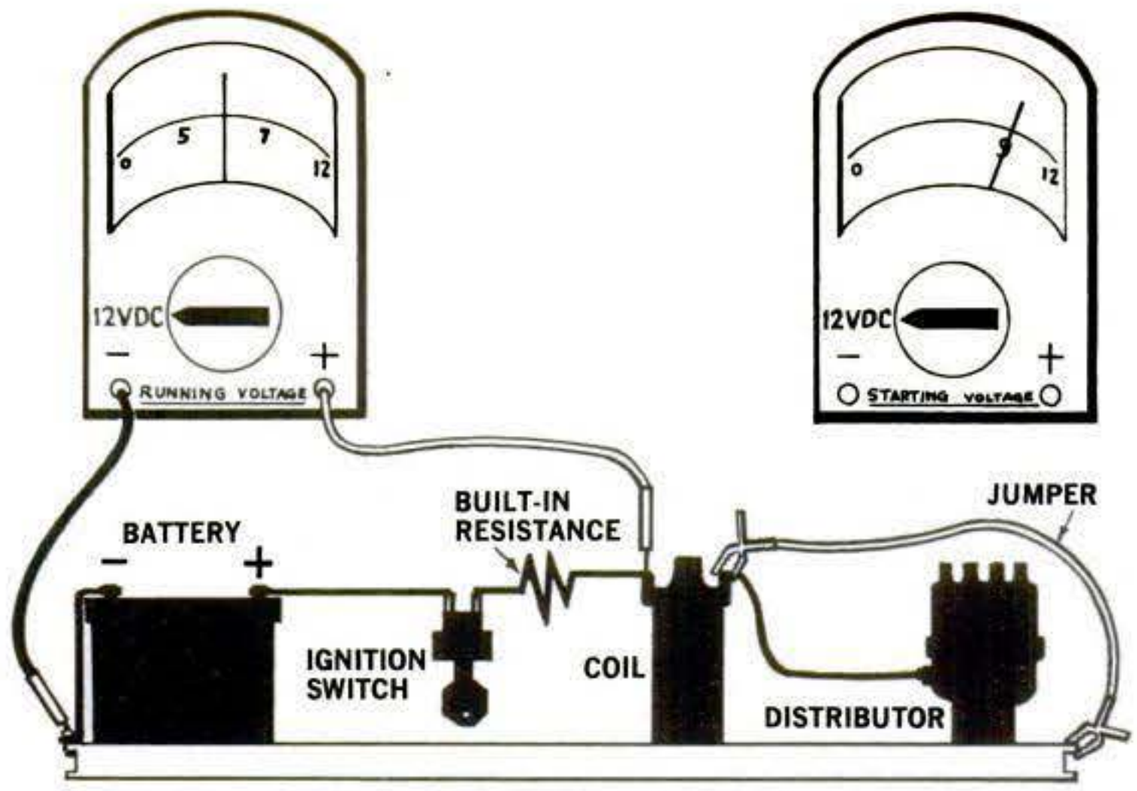


This simple test of spark-plug cables could save you time and money you'd otherwise waste on unnecessary plug changes.



PRIMARY VOLTAGE TEST

That Versatile VOM— Now It Troubleshoots Your Car

Keep running costs down by keeping performance up with these sure-fire checks

By RICHARD DAY

There's a real tiger for troubleshooting and maintaining the ignition system of your car—and you can own it for $20 or less. It's a volt-ohm-milliammeter—VOM for short.

With a VOM you can make go/no-go checks of primary wiring (non-transistorized ignitions only), coil, distributor points, spark cables, ignition switch, ground circuit, distributor cap, rotor, built-in primary resistance, and more. Without a VOM, problems in any of these areas can run undetected, costing you money because of poor performance from your engine.

Along with the VOM (if you're not sure how to use one, check Nov. '70 PS); you'll need a short No. 16 (AWG) jumper wire with alligator clips.

These testing instructions apply to nearly all U.S. cars with 12-volt negative-ground electrical systems. If your car has a positive-ground system, reverse the red and black lead hookups shown in the drawings.

One caution: *Never try to make primary circuit tests on an engine with transistorized ignition.* Even many pros pale at the thought. One wrong hookup can blow the system in a flash. The *secondary* circuit tests, however, will be okay on any ignition system.

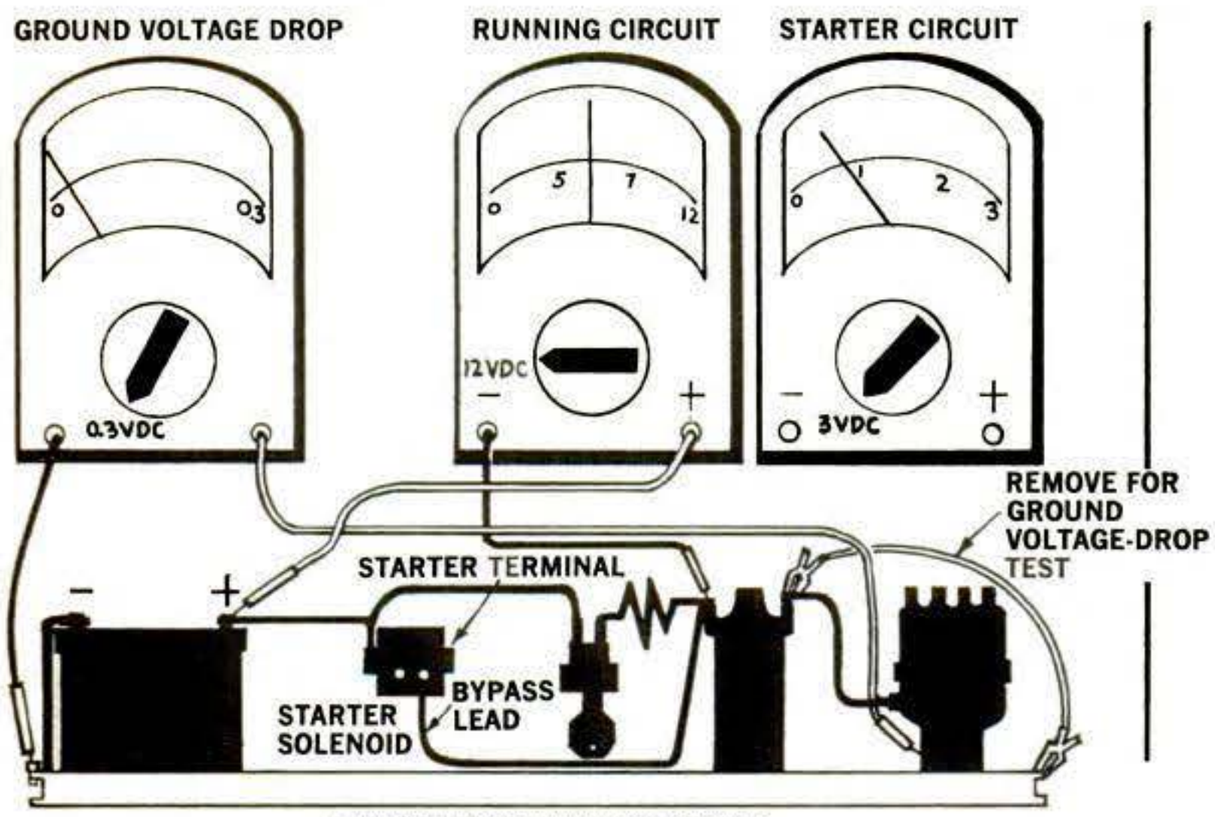
Before you start testing, measure the voltage across the battery with the ignition on, but the engine not running. If it's within the 12-15-volt range, you're ready to begin.

As you go through each test in the order given, you'll eventually narrow down a general problem to a specific part in the ignition system:

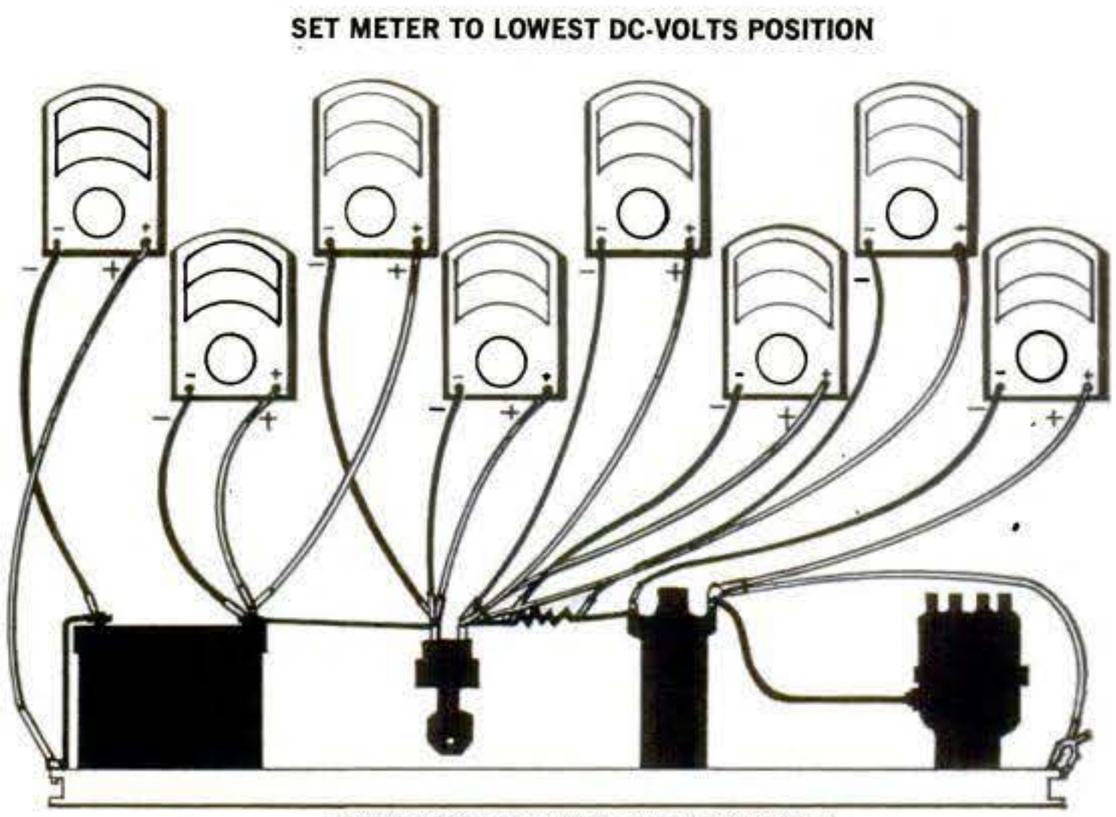
Primary voltage. One simple VOM hookup can give you an overall picture of how your engine's primary system is acting. You make it in two steps:

1. Nearly all U.S. cars use two-voltage primary ignition systems. Primary current for running is passed through a built-in resistance, reducing it enough to keep from overheating and burning distributor points. You can't see the built-in resistance because it's part of the car's wiring, but it's there. However, the second you turn the ignition key to start, the built-in primary resistance is bypassed. This feeds full battery voltage to the coil for a hot starting spark.

For the running voltage test, set the VOM to read 12v with the red (+)



PRIMARY VOLTAGE DROP



INDIVIDUAL VOLTAGE DROP

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lead to the battery primary terminal of the coil (BAT or B) and the black lead to a good ground. Turn on the ignition switch and add a jumper lead between the coil's distributor primary terminal and ground. The jumper will complete the ignition circuit, but eliminate the points and other distributor parts as possible causes of trouble.

Voltage should be reduced by the built-in resistance to about 5v to 7v at the coil. Flip the ignition switch off and on several times. At each *on*, the meter should read the same voltage. If it varies intermittently, the ignition switch is faulty.

If the running voltage reading is constantly less than 5v, there may be a loose connection between battery and coil, or the built-in resistance is open or has too high a valve. The primary voltage-drop test coming later will pinpoint the problem.

If the reading exceeds 7v, there may be a loose connection between coil and distributor. The distributor voltage-drop test will check that. It's possible, too, that the built-in resistance isn't even in the circuit because of faulty wiring or a short. It is meant to be bypassed during starting, either by the starter solenoid or ignition switch. Most cars from Ford, GM, and AM use the solenoid-bypass system. Chrysler products all use the switch-bypass system. The individual primary voltage-drop tests coming later should show you where the trouble is.

2. Switch the ignition key to the start position and watch what happens to the meter reading. The needle should read about 9v, indicating the battery voltage while under starter load. If there's any doubt, put the VOM across the battery posts—POSTS, not terminals—while someone cranks the engine. Read the voltage under starter load. It should be about the same.

Ford primary voltage during cranking reads more like 7v—up about a volt from running voltage. The main thing during a starting-voltage test is that the volt reading should be greater than during the running test. If it isn't, the bypass switching system may not be working. The voltage-drop tests will help you find the trouble.

Other possibilities: The starter may be drawing too much current from the battery, or the battery may be too weak to hold a decent voltage during cranking. A direct test on the battery will tell. If the battery can't hold about 9v while starting, you have a battery-starter problem.

Primary ignition voltage drop. This test, performed as a check on the primary voltage-level tests, will help to narrow down any problems.

It's a three-part test—running circuit, starting circuit, ground circuit. Leave the jumper lead connected from the previous tests. To test the running ignition circuit's voltage drop, set the VOM selector at the 12 DC volts position. Connect the red lead to the battery's positive post; the black one to the battery primary terminal of the coil.

The voltmeter will try to read battery voltage. Turn the ignition switch on, everything else off. The voltmeter should then read around 5v to 7v, or as specified by your car's manufacturer. (Ford says 4.5 to 6.9 volts.)

If the voltage-drop reading exceeds maximum, there's excessive resistance in the circuitry between battery and coil. First look for loose or corroded terminals on the battery, starter solenoid, ignition switch, and coil. If visual inspection doesn't pick up the trouble, the individual voltage-drop test (performed later) will. If voltage drop is less than the spec, the primary built-in resistance is at fault. Have your mechanic replace it. Don't tackle it yourself.

The starter circuit is tested with no change in connections. Reset the me-

Continued

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[Continued]

ter selector to the 3-VDC setting. The meter will read off scale to the right. Operate the starter and it should drop back to 1.5 volts or less. If the voltage drop is too much, there is a poor connection somewhere in the bypass switching circuit. Visually check for loose or corroded connections from ignition switch to coil or from solenoid to coil, depending upon the system in your car.

Voltage drop can also occur in the ground circuit between the distributor body and the battery negative post.

To make the ground-circuit test, first crank the starter until you're sure the points are closed, then remove the ground jumper. Reconnect the VOM —black prod on the battery negative post, red one on the distributor housing, as in the drawing.

The voltage-drop reading should be near zero. If not, check the individual voltage drops of distributor to engine, engine to ground cable, the ground cable itself, and ground cable terminal to battery post. Each should be near zero. If not, look for corrosion or loosening of terminals in the area you're checking.

Individual voltage drop. If you have found excessive voltage drop, these tests will narrow it down to the portion of the circuit that's causing it. You'll be measuring the voltage lost in each individual part of the ignition and starter circuit while under starter load.

Set the VOM to read at the lowest DC-volt scale. Reconnect the jumper wire from the coil's distributor terminal to ground and turn on the ignition switch. As shown in the drawing, place the test leads in turn across each connection, wire, and switch in the ignition circuit beginning at the positive battery post.

The red lead should always be on the side of the circuit leading toward the battery. Each test should be made with the engine cranking for maximum load on each individual circuit.

The portion of the circuit that gives a reading exceeding the following maximums is the offender:

Readings across all connections and terminals should be near zero. Battery cable-voltage drop shouldn't exceed 0.3v end to end, and the heavy wire from starter solenoid to ignition switch should show less than 0.05v drop. On Chevrolets and most other GM cars, the wires from battery positive post to ignition switch should not produce more than 0.4v drop. And reading across the two ignition-switch posts involved in the circuit should not show a voltage drop of more than 0.3 volts.

Repair or replace any faulty portions of the circuit, then retest.

Distributor voltage drop. Good electrical continuity is as important through the distributor as in the rest of the primary ignition circuit.

First you test for proper ground. Disconnect the jumper wire from the coil's distributor terminal and set the VOM selector to the 12-VDC position. Connect the red lead to the distributor primary terminal of the coil, the black lead to a good ground on the engine. Turn on the ignition switch, everything else off. Open the points by jigging the starter until the meter reads battery voltage. If it won't, the points aren't opening or there's a ground in the coil-to-distributor wire or in the distributor itself. You should be able to find it by careful inspection.

Next, work the starter until the points close and the meter swings back toward zero. You can then safely switch the selector to the next lower position. The needle still shouldn't move much from zero. Finally, switch down to the lowest DC volt position. Now the needle may move some, but the reading should not be more than 0.1v for a pair of new points.

The lower the reading the better, because it indicates voltage lost due to internal distributor resistance. Burned points, a poor inside-distributor connection, or a bad internal wire can cause too much voltage loss.

If distributor voltage drop is too high, check each part of the system separately. Test the coil-to-distributor wire, the lead-in wire (if there is one), across the closed points, stationary breaker point to breaker plate, breaker plate to distributor housing, and distributor housing to engine ground. All readings but those across the points should be zero. The faulty component will be the one that shows a high voltage drop.

Coil primary tests. So far you've checked up to the coil from both sides. Now check the coil itself. There are two tests on primary and one on secondary coil windings. All are ohmmeter tests made with the coil's primary wires disconnected for isolation. As you remove wires, tag them with tape for identification.

Coil primary ground. The coil primary windings should have no continuity with the body of the coil. To test, set your VOM to the highest ohm setting. Touch one test prod to either primary terminal of the coil and the other to the coil's metal body. The needle should not move. If it does, get rid of that coil.

Coil continuity. A coil with open primary windings has had it. Set the selector to the lowest ohm position. Touch a lead to each coil primary terminal; the reading should be less than two ohms.

Proper resistance in the secondary coil is essential for a good spark. With the VOM selector in Rx100 position, hold one test prod down into the coil tower so it's in firm contact with the metal terminal. Touch the other prod to one of the coil's primary terminals. Compare meter reading with specs.

Typical Big-Three specs: Ford coils, 7,600- to 8,800-ohms secondary

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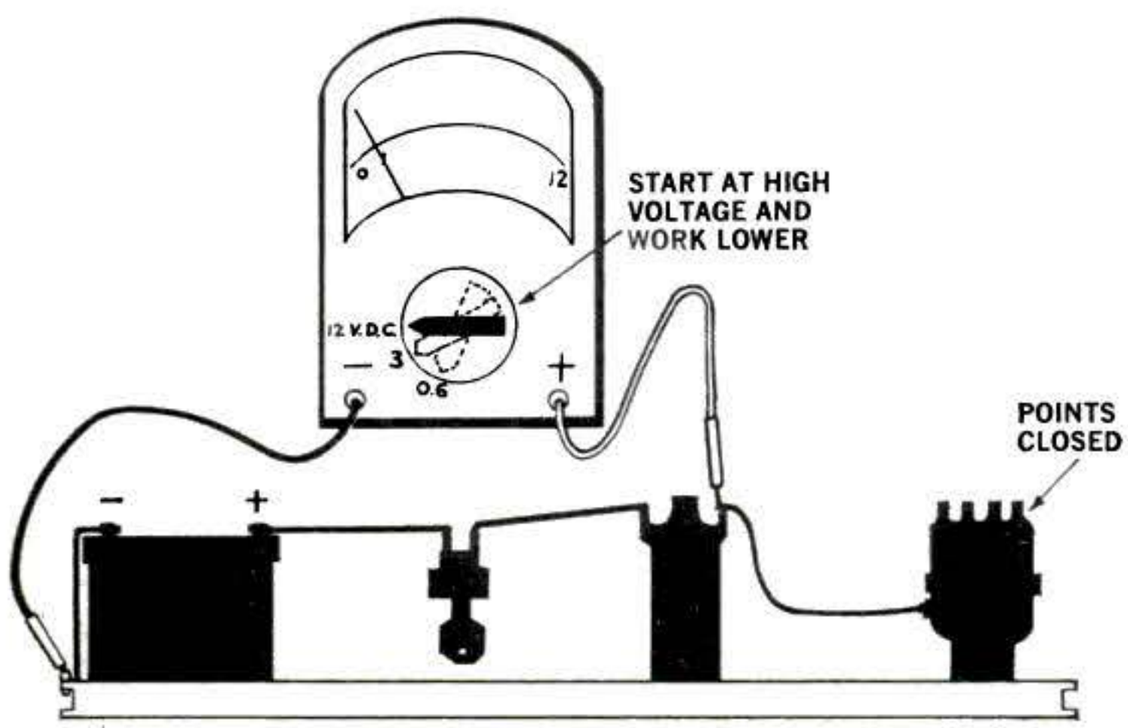
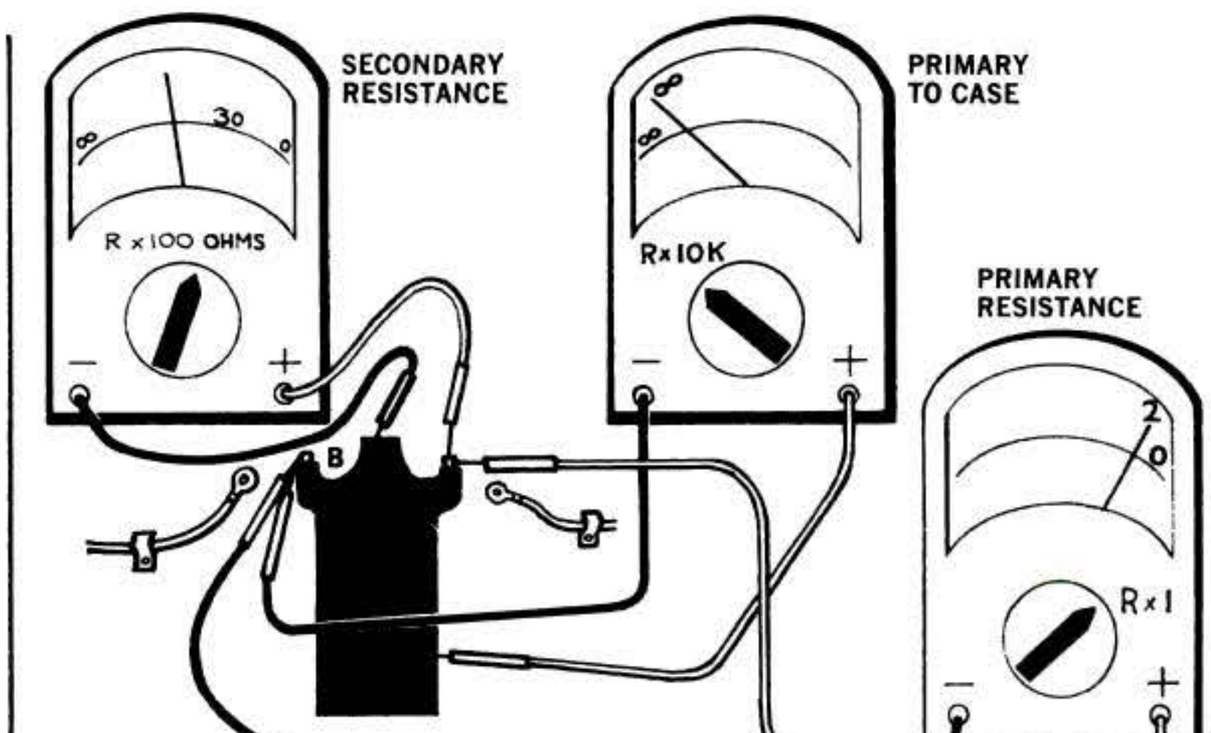


DISTRIBUTOR VOLTAGE DROP



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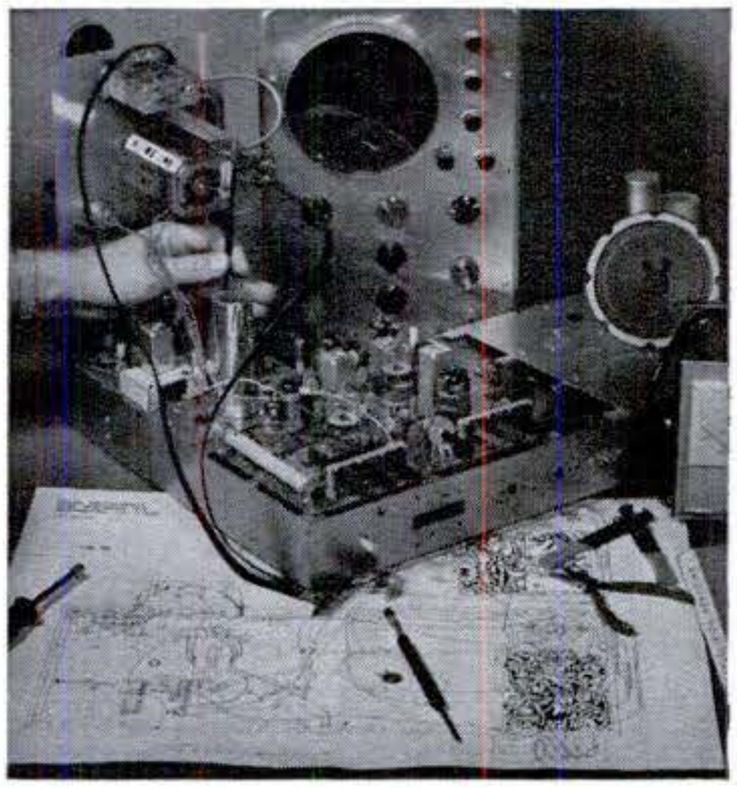

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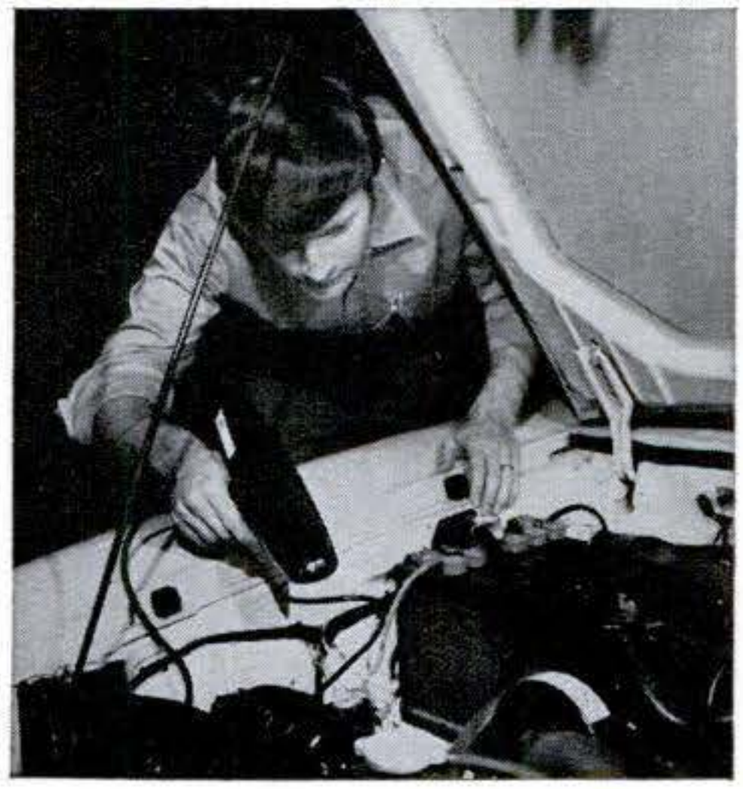

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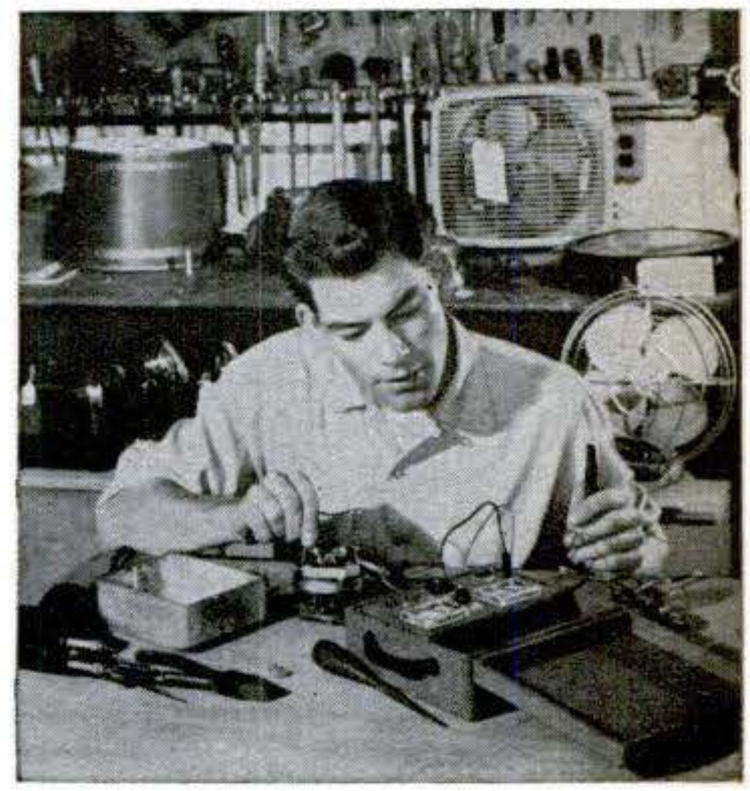

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[Continued]

resistance at 75 degrees F; Chrysler coils, 9,200 to 11,700 ohms; Chevrolet, between 3,000 and 20,000.

If the coil secondary resistance tests outside specs, replace it.

Ignition cable resistance. Resistance was put into spark-plug cables to reduce continued sparking after the initial jump, thereby minimizing spark-plug electrode erosion. It also lessens radio-frequency interference. But these resistance cables deteriorate with age to the point where one or more cylinders misfire. This too-common problem can send you on a wild-goose chase, replacing plugs that are actually okay.

To measure spark cable resistance, remove the distributor cap with all its cables intact and pull the coil-to-distributor cable out of the coil tower. Set your VOM to measure ohms on the Rx100 scale and touch one test prod to the end of a spark cable up inside the boot. Touch the other prod to that cable's terminal inside the distributor cap. Scrape the prods on the metal terminals if it helps to lower an ohm reading.

Resistance specs for spark cables vary according to the make of car. Although generally the longer a cable is, the more resistance it will have (twice the length, twice the resistance), the average is about 20,000 ohms. After you've tested all the wires, if any one is far higher in resistance than the others, you'll know without looking at any specs that the wire needs replacement.

Every wire that you test should be snaked around while the VOM is connected to it. Movement may show up variations in resistance caused by a broken conductor. If this happens, get a new wire.

Solid-core nonresistance cables should be checked, too. Readings from end to end should be near zero ohms. If there is significant resistance, replace the cable or its terminals.

Resistor spark plugs. Resistor and Champion Booster Gap spark plugs can be checked with a VOM. Set the selector to Rx100 ohms. Touch one prod to the spark plug's outer terminal and the other to the center electrode. The reading on most resistor plugs should be between 10,000 and 20,000 ohms. Chevrolet says about 5,000 ohms. If it is higher, replace the plug no matter how good it appears.

Booster Gap plugs should show infinite resistance from end to end of the center electrode. VOM tests on standard spark plugs are meaningless. Don't bother.

Distributor cap/rotor continuity. Distributor cap and rotors can develop shorts through carbon tracking that's not apparent to the eye.

Set the VOM selector to highest ohm position. Touch one prod to the rotor's metal end and move the other around on the insulated rotor body. To test the distributor cap, touch one prod to a metal contact and move the other around on the distributor-cap body. Repeat for every contact and terminal, working from inside and outside the cap. All measurements should show infinite resistance.

If you find a crack or carbon track, replace the part. Otherwise the problem is sure to recur. Replace the affected spark cable, too, because the carbon track will also be inside the boot on the wire. Be sure the coil tower, distributor cap, and spark-plug insulators are wiped clean. Grease and salt deposits on these parts are a major cause of hard starting in damp weather. PS

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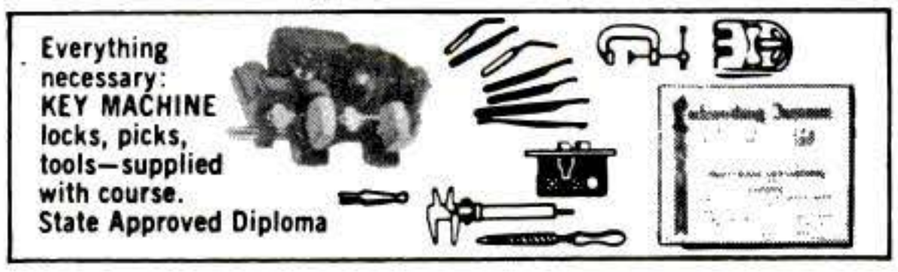

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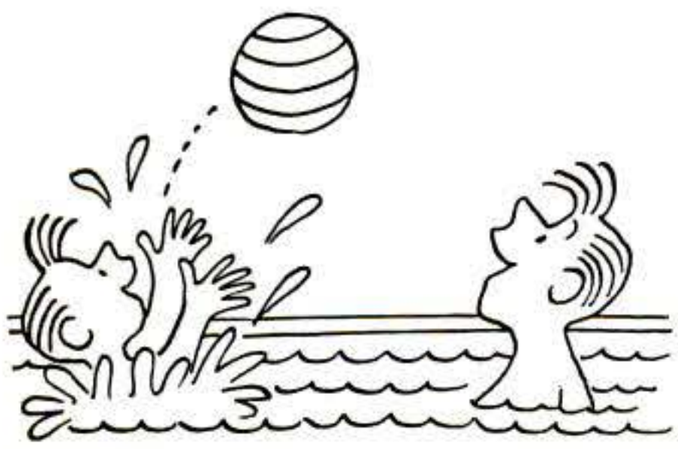
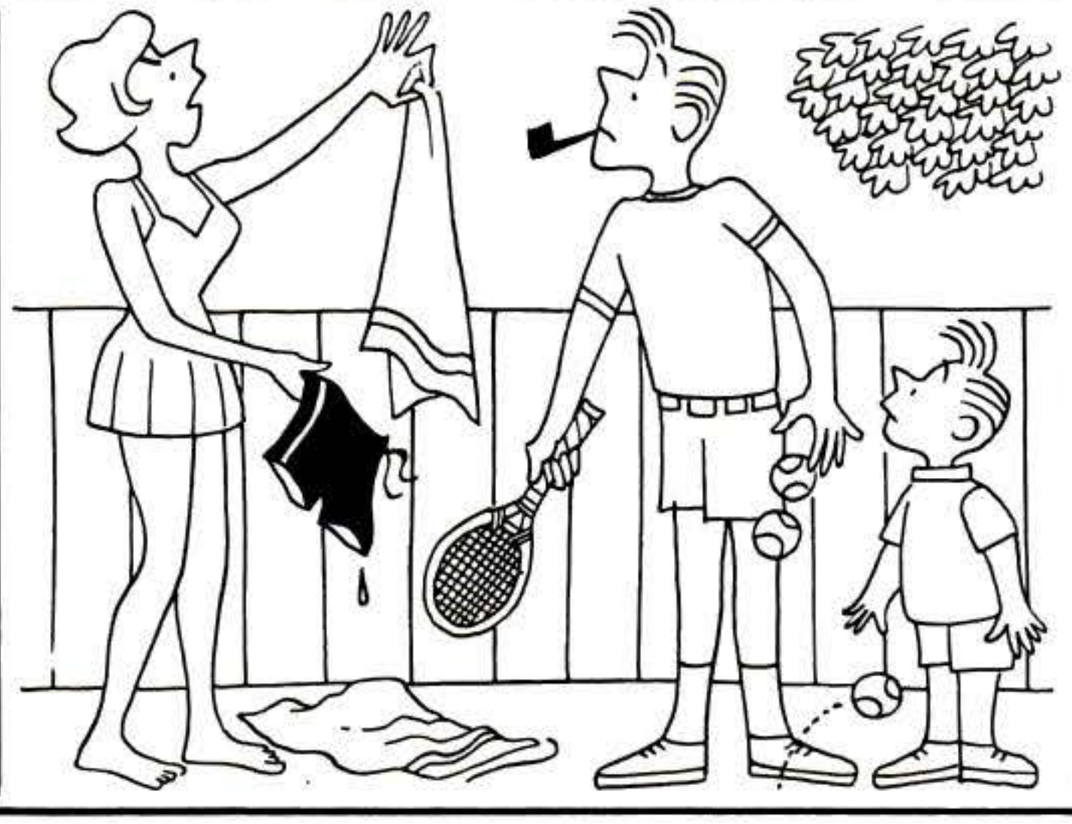
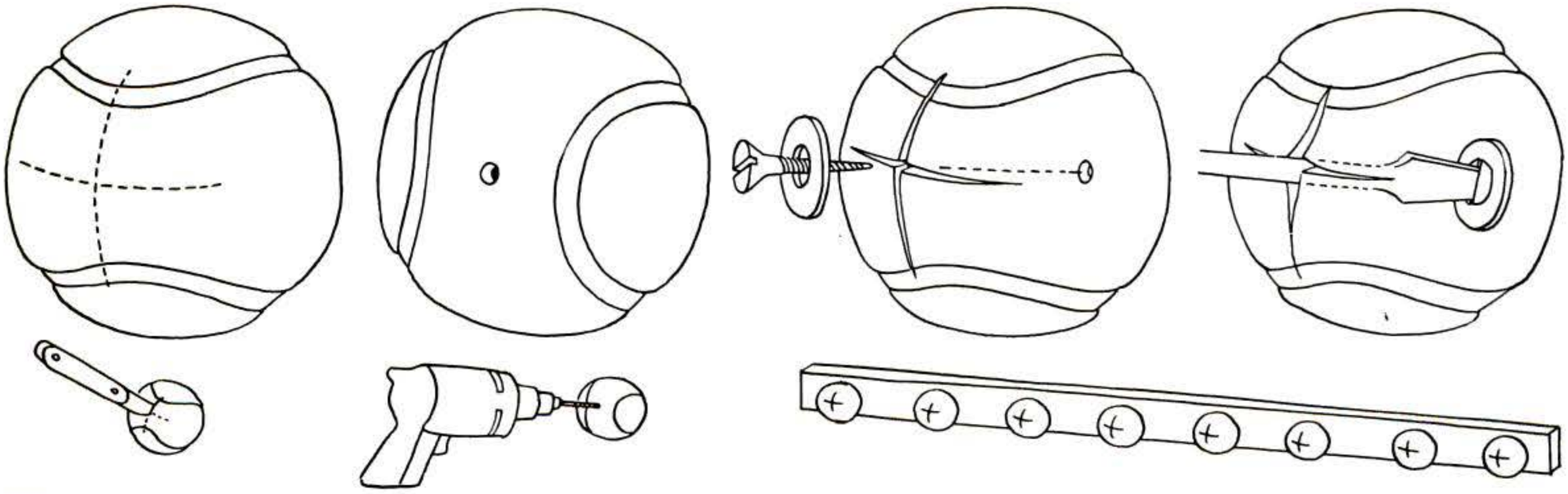
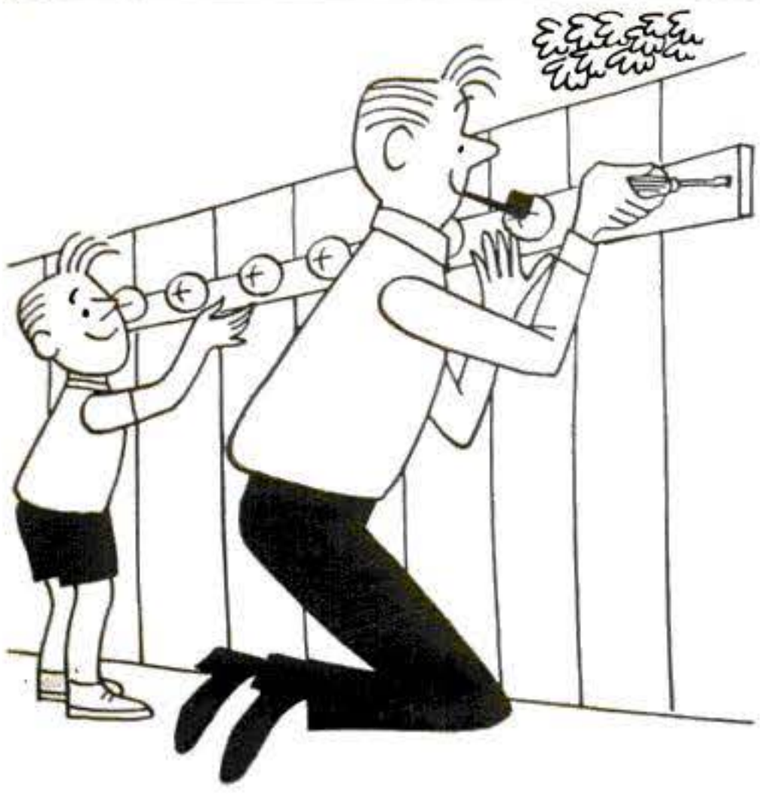
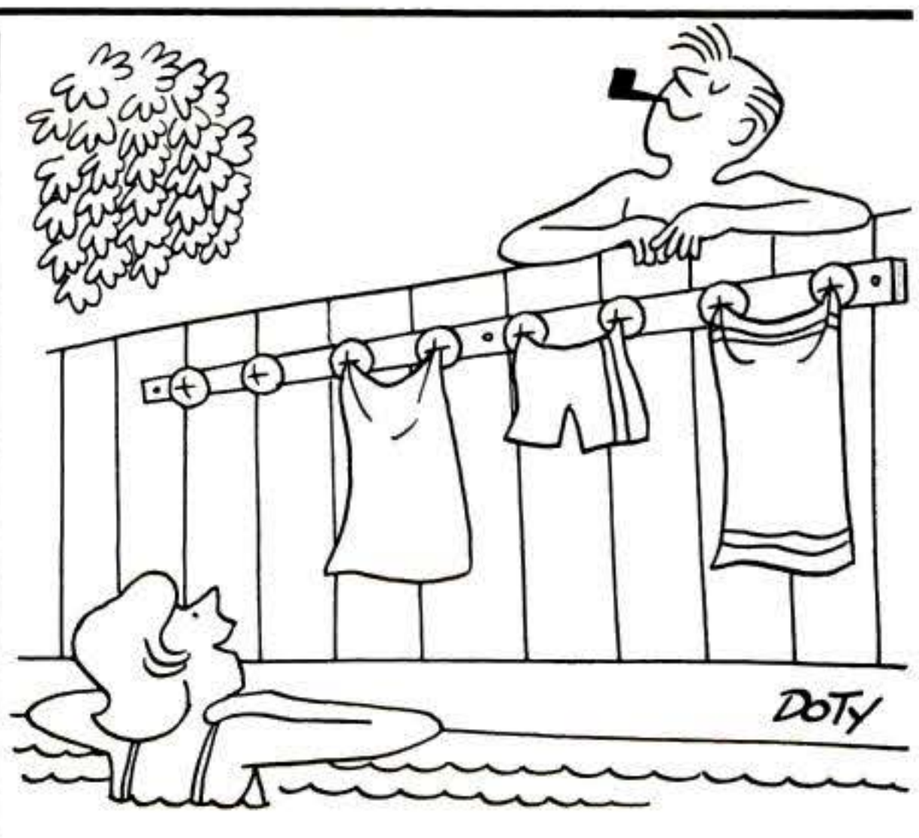
By ROY DOTY











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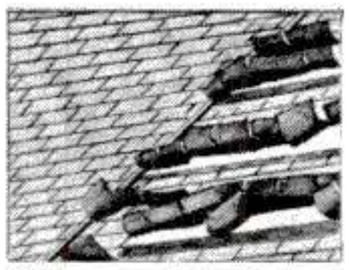
Before you spend a couple of thousand for a new roof, spend a couple of minutes to learn about roofing.

Protecting your home from wind and water damage

A leaky roof means rotting attic timber, stained ceilings and walls – and in a bad storm – costly water seepage that can ruin furniture and furnishings.

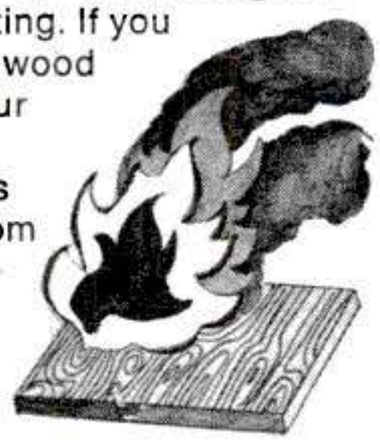


Bird Other Shingles

The Bird Wind Seal® line of asphalt shingles helps protect you from high winds. Each shingle is made with thermoplastic dots (about 19,000 on an average roof). The sun's heat melts these adhesive dots, welding the shingles together in a grip that fights against letting go – even in hurricane-force winds. (To get Underwriter's Laboratories approval for wind resistance, shingles must be tested in 60 mph winds. We tested Bird Wind Seals in *120 mph winds.* In this test not a shingle ripped off, while those without the Wind Seal feature tore loose, allowing water to come in.)

Protecting your roof from fire

Wood shingles, or shakes, are attractive, but can be dangerous. Flying embers – even sparks from a fireplace chimney – can ignite them. That's why they're outlawed in some areas. The Bird Firescreen® shingle rates Class "A" in resisting fire – the UL's highest rating. If you still like the look of wood shakes, look into our Bird Architect® 70 shingle. It simulates the beauty of random wood shakes, combined with the fire protection of finest quality asphalt.



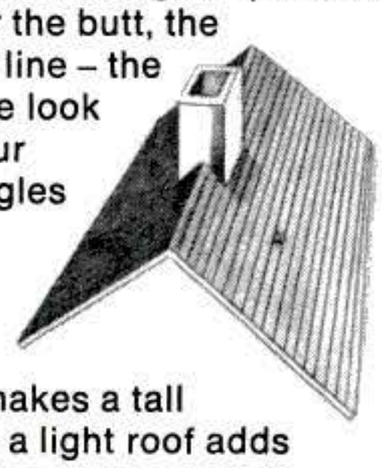
Cost of labor vs. cost of shingle

If you check out slate shingles, you'll find the cost in materials and labor prohibitive. Wood shingles, too, are costly to buy and apply. That's why today's sophisticated asphalt shingles are such a good buy. Whether you buy the low end of the line or the highest quality, you get excellent value and minimum, if any, upkeep.

Remember this – the costs are comparable for labor to apply the best asphalt shingle or the least expensive. Since the labor cost will be very much the same, you should think about paying a little extra for a top quality shingle with all its extra protection and beauty. What's more, the best shingles offer a 25-year materials guarantee, the less expensive ones 15 years.

Choosing the right shingle for your home

The architecture of your home and its surroundings dictate the style of shingle to buy. A roof should present a long, clean line. It should show deep shadow lines at the butt edges (the butt being the part that shows). The thicker the butt, the deeper the shadow line – the more impressive the look of your roof and your home. All Bird shingles with the important Wind Seal feature have thick butts.



Don't overlook color. A dark roof makes a tall house look shorter, a light roof adds height to a one-story house. A medium color blends nicely into wooded backgrounds. Greens are restful, white cooling and a bright roof adds its own "surroundings" in an area bare of trees.

Another aesthetic feature is *random-embossing.* Instead of conventional cutouts, many Bird shingles have vertical indentations. They add to your roof's long, clean line – no more broken-up, cluttered look that old-fashioned cutouts give.

The Bird Wind Seal JET® looks great on ranch-style and long contemporary roofs. And the Bird Architect 70, with its wood shake look, is ideal for gambrel, mansard and barn-type roofs. And stunning on colonial homes.

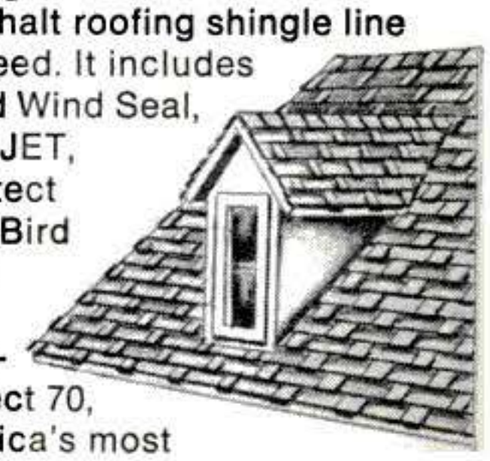
How shingles are sold

Shingles are sold by the square – a square being enough shingles to cover 100 square feet. You can buy them and arrange for application at a lumber dealer's, a home improvement company or a contract roofer.

Shingle weight determines its cost. The lower the weight, the lower the price. But the heavier the shingle, the better your roof. Since labor is a large cost factor, do not discount the heavyweights. The price spread between the Bird Wind Seal at 235 lbs. per sq. and the Bird Architect 70 at 345 lbs. per sq. isn't so great that it should discourage you from considering the finest protection and beauty for your home.

The Bird Shingle Line

The Bird asphalt roofing shingle line covers every need. It includes the famous Bird Wind Seal, The Wind Seal JET, The Bird Architect Mark 25®, The Bird Firescreen and the new bold, brawny, beautiful Bird Architect 70, probably America's most beautiful shingle.



To see Bird shingles first hand, mail coupon for an illustrated brochure, or see the Yellow Pages for the name and address of the Bird dealer nearest you.

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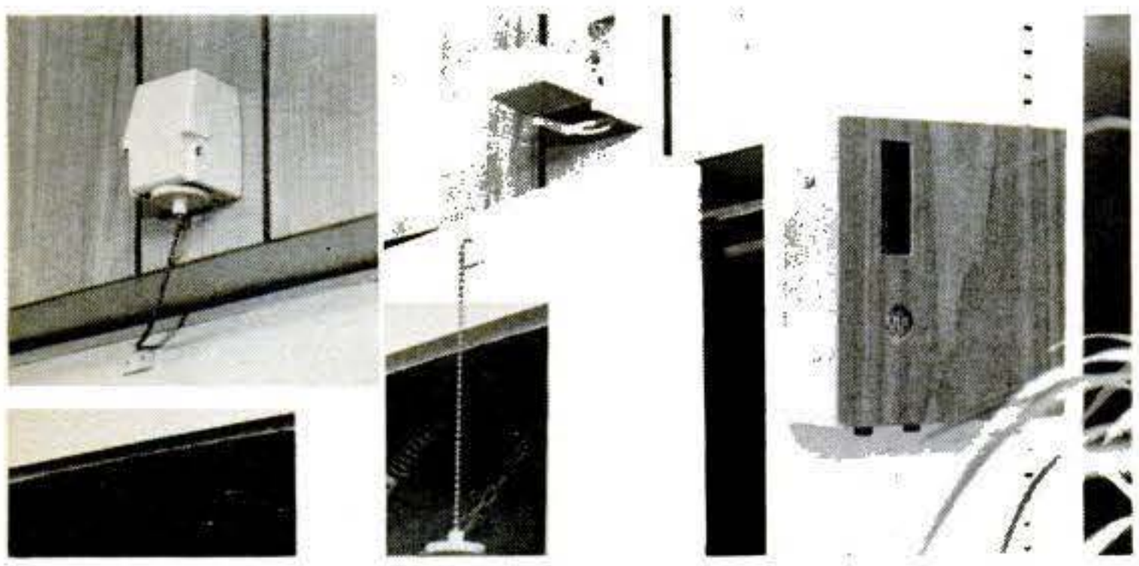
Flashguard Magicube can be mounted near any opening; light-sensing alarm center can be up to several hundred feet away.



Wireless Burglar Alarm Works in a "Flash"

Saturday-night thieves will have a tough time foiling this one. Defensive Instruments, Inc., borrowed Sylvania's Magicube camera flash and ended up with Flashguard—an ingenious, low-cost, burglar-alarm system.

There's no need to install extensive wiring as with other alarm systems; four D-cell batteries power an alarm bell. Even if there's a house-power failure, the system will still operate.

The two-inch-square Magicube (containing four bulbs) fits in a plastic case mounted on a door or window jamb. When the thief enters, a chain trips a torsion spring in the cubes firing two of its four flashbulbs. The high intensity light pulse is picked up by a light-sensing device, which triggers a bell or alarm (or even a warning signal at your local police station).

You must, of course, keep a clear line of sight between flashcube and sensor. Ambient light is no problem; only a high-intensity flash sounds the alarm. To permit you silent entry at the most frequently used entrance, one flash unit has a built-in time delay.

Price? Between $300-$350 installed. You get seven window/door flash units, one entry/exit flash with an 18-second delay, two alarm control sensors, and two alarm bells. For more information write Flashguard, Inc., 927 Penn Ave., Pittsburgh, Pa. 15222.—*Doug Garr*

Triggered (left), two bulbs flash when door is opened (center). Sensor (right) receives pulse, sounds alarm.

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[Continued from page 68]

speakers, and all cars have channeling under the door sill for cables running to the rear. Usually three or four screws hold the sill in place, and there's plenty of extra room for speaker wires.

Four-channel rigs double your work, of course, since you'll need two speakers in front, another pair in the rear. But the same techniques and principles apply.

Battery connections. The most practical and convenient source of switched battery voltage is from the fuse holder, which is generally mounted on the firewall. One half of a discarded fuse clip soldered to the end of the tape-deck hot wire will make a perfect connector. Find a fuse in the holder that controls an accessory that is turned off with the ignition key, such as the radio or windshield wipers. Remove the fuse and force it into the fuse clip. Then, while spreading the fuse-block terminals, push the clip and fuse back into the fuse holder. Use a spade lug on the ground wire and slip it under a convenient screwhead under the dash. Needless to say, make sure there is a good electrical chassis-ground connection.

For camper or boat. You can keep your system on the go with you at all times simply by using identical connectors in your car, camper, or boat for speaker and battery wiring. Going camping? Use the system in your car until you set up camp. In minutes you'll have the system playing through new speakers in or around the camper.

You may wish to make a permanent speaker installation in your camper. Here you've got a lot of wall space to choose from and you're not restricted to speaker size. You've got a large assortment of areas to place the deck as well. One out-of-the-way place for the Afco four-channel player ($139) is in an unused closet or shelf. It nicely qualifies since all its controls are easily accessible from the bottom. Slide controls balance the front/rear and left/right speakers, and thumb dials control volume and bass. Just a couple of screws through an extra mounting bracket will hold the unit in place.

For a quick installation, you can use the lightweight Weltron two-channel unit ($54.95) that can simply hang by its own bracket. It's an eye-catching unit, too—a traditional metal case with a brightly colored plastic cover. Multicolored lights and slide switches complement the face. A bargain at that price.

And don't forget the outside of your camper. If you like singing around the campfire, why not have an accompaniment? An extra connector mounted in the outside wall of the camper will let you plug in a speaker system. When not in use, the speakers can be kept inside the camper.

Another accompaniment to these decks—one that no one wants—is theft. Although some decks have built-in alarm systems, most do not. The circuit shown can be easily placed in any deck and will sound an alarm if the unit is removed.

Resistors R1, R2, and R3 make up ¾ of a balanced bridge cricuit. For the bridge to "balance out," keeping the relay open, there must be 560 ohms across the Jones plug. If a thief cuts the wire leading from the deck (infinite resistance) or if he decides to short the wires to defeat the system (0 ohms), the alarm will be activated. Remember, however—this is an alarm, not a preventative. The best preventative is to keep the unit always in sight. PS

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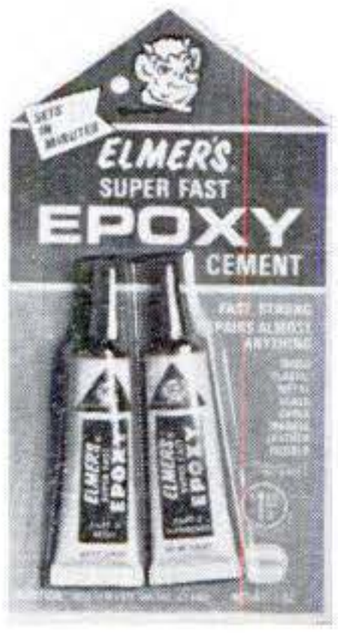

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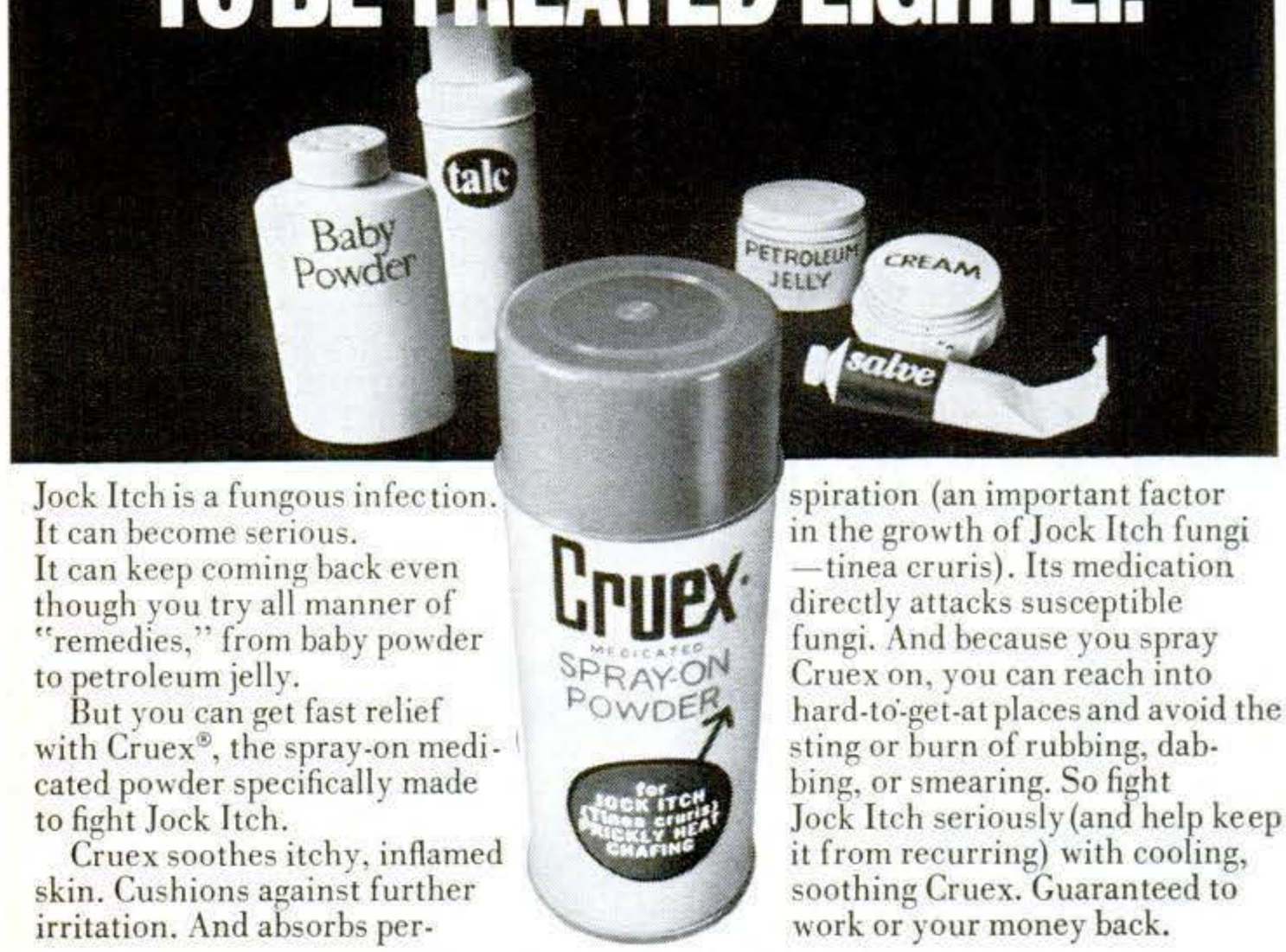
JOCK ITCH ISN'T SOMETHING TO BE TREATED LIGHTLY.



Jock Itch is a fungous infection. It can become serious. It can keep coming back even though you try all manner of "remedies," from baby powder to petroleum jelly.

But you can get fast relief with Cruex®, the spray-on medicated powder specifically made to fight Jock Itch.

Cruex soothes itchy, inflamed skin. Cushions against further irritation. And absorbs perspiration (an important factor in the growth of Jock Itch fungi —tinea cruris). Its medication directly attacks susceptible fungi. And because you spray Cruex on, you can reach into hard-to-get-at places and avoid the sting or burn of rubbing, dabbing, or smearing. So fight Jock Itch seriously (and help keep it from recurring) with cooling, soothing Cruex. Guaranteed to work or your money back.

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Kodak's Pocket Instamatics

[Continued from page 61]

blood vessels of the subject's eye.

We recommend also that you do some "dry runs" with your Pocket Instamatic before loading it with film. The stiff shutter release (necessary, presumably, to keep the camera from accidentally going off when you drop it in your pocket) and the minimal hand-holding surface combine to make the camera difficult to hold steady; and you may find, as we did, that there's no completely happy way of holding it for a vertical shot.

The film. The new 110 cartridge looks like a miniature of the 126 Instamatic cartridge, but there are two big differences: The film is held flatter in the camera's focal plane by means of spring tension, and a paper backing for the film permits you to keep track of exposures through a window in the back—just as in the old box cameras. The film stock is 16mm, with a negative size of 13 by 17mm—roughly ½ by ⅔ inch (and, in case you wondered, about 2½ times the size of a Minox negative).

Four films are offered in the new 110 size: Ektachrome-X and Kodachrome-X for transparencies, Verichrome Pan for black-and-white prints, Kodacolor II for color prints. The Kodacolor II is a finer-grain version of the standard Kodacolor-X. Eventually, says Kodak, it will replace Kodacolor-X in all film sizes. Our experience with three rolls of Kodacolor II didn't show it to be all that different, but we'll withhold judgment pending further experience. We did, as expected, get first-class results with Kodachrome-X. Prices for 110? The same as for 126 cartridges. Ditto for processing and prints.

The projectors. Three new projectors—shrunken versions of the standard Carousel—take the new transparencies. All are automatic; all take a 120-slide circular tray; all have the same fine 2½-inch, f/2.8 projection lens. Model 100 is $99.50. Model 200 (with remote control and focusing) is $149.50. Model 300 (with remote everything plus automatic focus) is $214.50.

Can you use your present 35mm (2x2) projector for 110 transparencies? Yes, by means of a special 2x2 adaptor into which you slip the plastic 110 slide. Disadvantage: The image will be about a quarter the size of a standard 35mm image.

Kodak has high hopes for the new 110 system. It's seven years now since Instamatics first came on the scene and worked a revolution in picture taking. The smaller Instamatics may well do the same—in a smaller way, of course. PS

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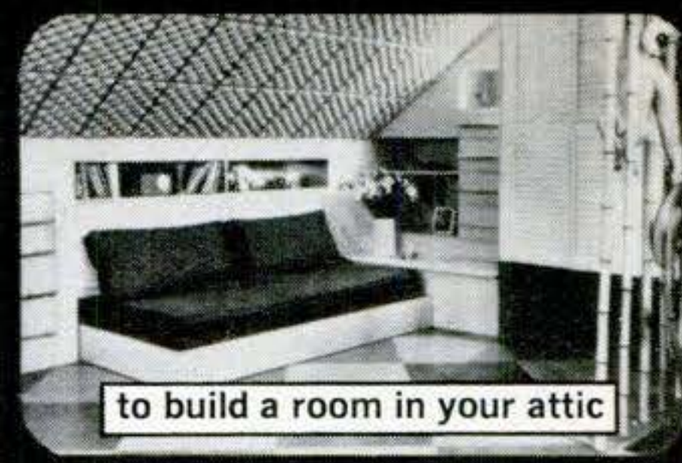
If only you knew how...

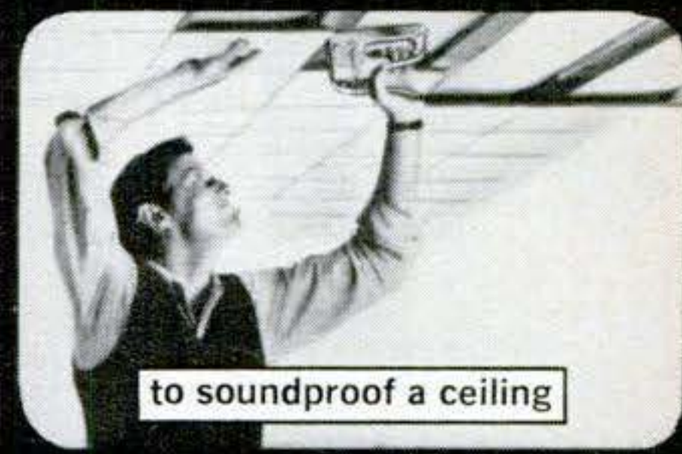
to start a stalled car

to refinish furniture


to build a room in your attic

to make a burglar alarm

to stop a leak in the basement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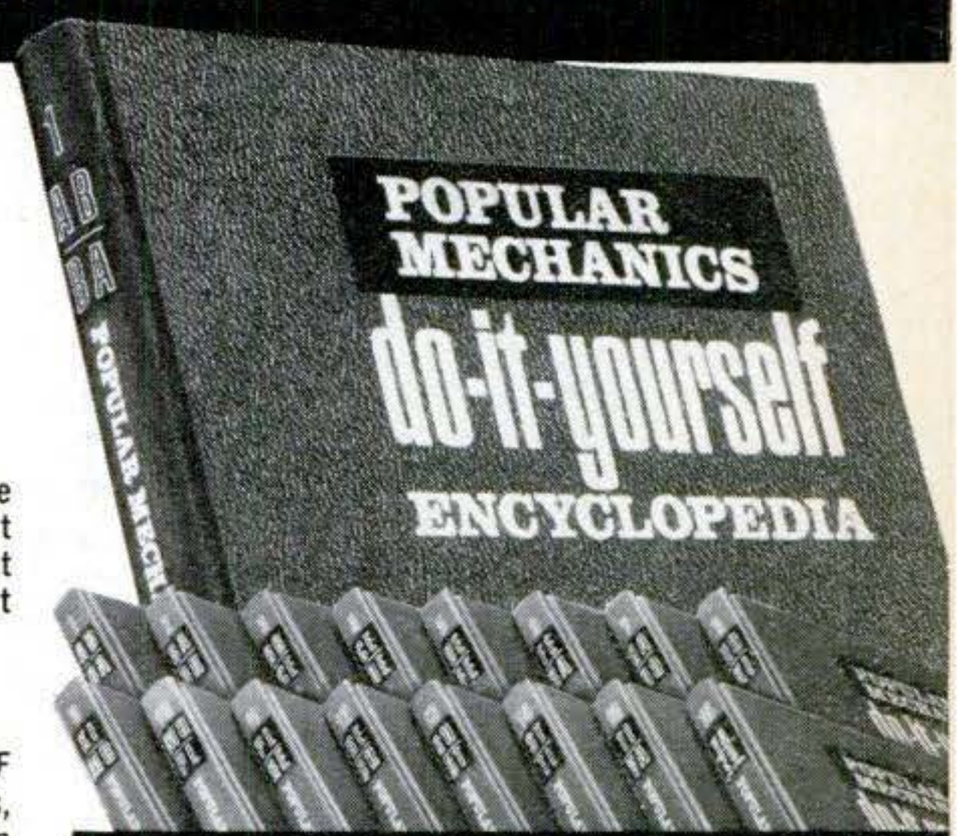

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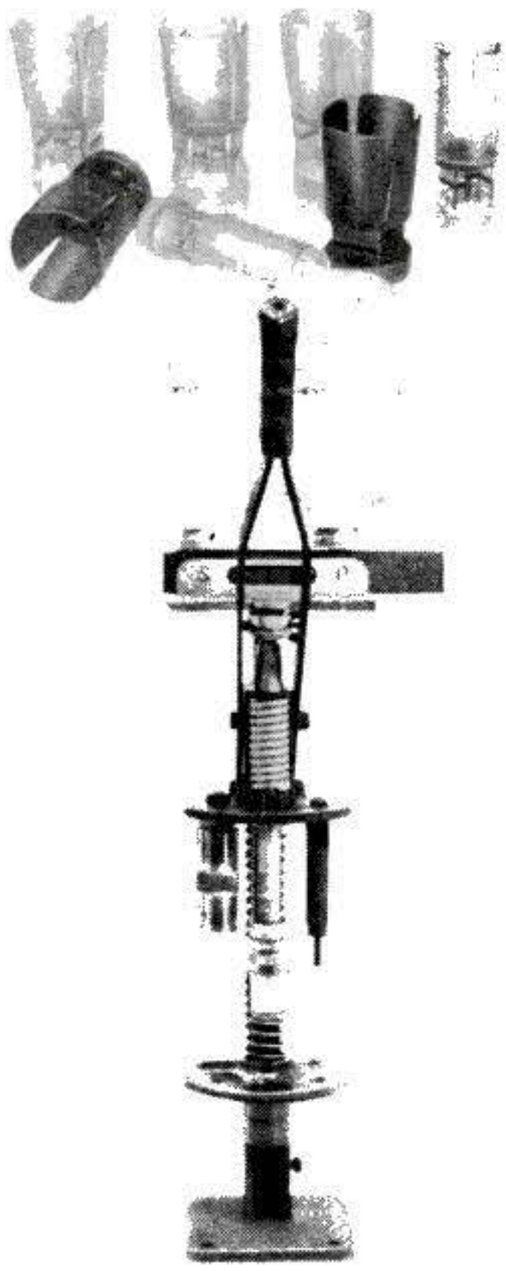

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Hang Gliders—Low and Slow, and Easy Does It

[Continued from page 94]

1902 glider and 1903 Flyer (world's first successful airplane) but flew them at Kitty Hawk for the film.

A remarkable teen-ager, Taras Kiceniuk Jr., is designer-builder-pilot of the Icarus, an outstanding hang glider. A tailless biplane, it is controlled in turns by tip-draggers (rudders at the wingtips) operated by a pair of twist grips. With a 29-foot span, this flying wing weighs 45 pounds in the original version; the improved Icarus II is about 10 pounds heavier. Airborne, the pilot can settle into a seat like that of a child's swing, taking the load off his armpits. At 18, Taras Kiceniuk is a top pilot, and his spectacular sky-surfing performances highlight every fly he attends.

A swinger. Volmer Jensen, of Volmer Aircraft, built and flew his first hang glider in 1925, long before most of today's birdmen were hatched. Now a vigorous 62, he recently soared 5½ minutes in his latest creation, the VJ-23—probably the most sophisticated hang glider ever built. Jensen is well known as a designer of sailplanes and for his home-built amphibian VJ-22 Sportsman, of which more than 50 are now flying.

Jensen's VJ-23, the Swingwing, is a unique cantilever monoplane glider with 32½-foot wing. It is fully controllable, like an airplane; one stick operates ailerons, rudder, and elevator. At 100 pounds, the VJ-23 is much heavier than the typical hang glider, and more than most pilots would want to carry in the usual takeoff and landing runs. Jensen, who doesn't care to run, designed VJ-23 for flying in 15-mph winds, strong enough so running is not required to get airborne.

Plans for the Swingwing monoplane aren't yet available, but Volmer Aircraft offers plans for the earlier VJ-11 So-Lo, a biplane glider with standard aircraft controls.

The kites. Despite the nostalgic appeal of replica biplanes and the high performance of craft like Kiceniuk's Icarus, a majority of sky surfers are flying on Rogallo-type wings. These man-carrying kites, when well designed and constructed, are good fliers and give you the controllability needed for soaring. Cheap and easy to build, they're readily transportable, can be assembled and disassembled at the gliding site in a short time.

Named for NASA scientist Francis M. Rogallo, inventor of this delta-wing kite, the basic Rogallo (there are many variations) consists of two leading-edge spars set at 45 degrees to the longitudinal keel; a crossbar and rigging wires hold things together; the sail, usually of plastic sheet, is attached to the framework of this kite.

Poles and pipes. Credit for introducing the Rogallo system to the hang-gliding fraternity probably belongs to Richard Miller, former editor of *SOARING*, the Soaring Society of America journal. Nearly a decade ago, he designed and built—for $9—a stiffened Rogallo kite he called the Bamboo Butterfly because its frame was made of bamboo carpet poles. From this kite evolved the Bat Glider, with 23-foot keel and 16-foot-square polyethylene sail.

Kiceniuk's Batso is a similar design. A later Miller development is the Conduit Condor sailwing; its chief component, electrical conduit.

Dick Eipper—of Eipper-formance Flight Systems—has owned and extensively flown two-dozen kites. Now, he has designed an improved Rogallo-type soarer—the Flexi Flier—and is marketing excellent plans and instructions for building it. Eipper, a trim 145-pounder, flies the 15-footer, but recommends the 18-foot version to heavier pilots (additional wing loading increases speed).

Exciting a lot of interest these days is Dave Cronk's just-fledged Cronk Kite 3—a high-aspect-ratio Rogallo with a 38½-foot span on a 13½-foot keel. It needs no wind for gliding flight, soars in a gentle breeze. Spoilers at the wing tips, operated by an ingenious system of shoulder-pressed levers, provide good turning control. Cost to build, with new materials, is about $130; an expert scrounger might do it, with surplus materials, for half.

Most hang-glider pilots build their own craft. Store-bought kites, like those produced by Australian pros Bill Bennett and Bill Moyes, sell in the $500 bracket. You can build a good Rogallo in a couple of days, usually for under $50. The more intricate biplanes can take hundreds of hours to complete. PS

Where to get hang-glider plans:

Eipper-formance Flight Systems, P.O. Box 246, Lomita, Calif. 90717—Flexi Flier, $5. *Jim Foreman*, 4335 Mesa Cir., Amarillo, Tex. 79109—Bat Glider, $5. *Taras Kiceniuk Jr.*, 2816 Highview Ave., Altadena, Calif. 91001—Batso, $5; Icarus II, $10. *Jack Lambie*, 9460 Artesia, Bellflower, Calif. 90706—Hang Loose, $3. *Volmer Aircraft*, 104 E. Providencia Ave., Burbank, Calif. 91502—VJ-11 So-Lo (biplane) plans, $30; data kit, $2. *Low & Slow* magazine, 59 Dudley Ave., Venice, Calif. 90291—plans for Miller Sailwing (L&S issue No. 5), Kilbourne Rogallo (No. 6), 1909 biplane (No. 11), Cronk Kite 3 (No. 12). These issues $1 apiece. L&S is a gold mine of information on this growing sport and related areas like man-powered flight.

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SHOP TALK

By ROBERT P. STEVENSON

Help for those who repair engines and cars

Sears makes a direct appeal to do-it-yourselfers in its '72 auto-parts catalog. A statement on the cover says: "If you've been hesitating about installing auto parts yourself, this catalog might change your mind." Instructions inside include checking plugs, points, rotor, and gap, using a dwell tachometer, and checking timing. Many Sears parts come with installation instructions.

If you have occasion to work on two-cycle engines, you may be interested in a new 104-page service manual published by the Product Training Center, Jacobsen Mfg. Co., 1721 Packard Ave., Racine, Wis. 53403. Write to the center for more information about the manual.

Operate summer air conditioner like winter heating

You should apply many wintertime heating practices to the operation of a summertime central cooling system. This advice is included in a new circular, "Cooling Systems," (15 cents) from the Small Homes Council, Univ. of Illinois, 1 E. St. Mary's Rd., Champaign, Ill. 61820. In summer keep an air-conditioned home closed throughout the day and night. Let the thermostat control the cooling system.

Your lawn as an air conditioner

While you mow your lawn this summer, you might think of the good things it does besides provide a setting for your home. Dr. William H. Daniel, Purdue University agronomist, calls a lawn an "air conditioner deluxe," with an acre of grass equivalent to 70 tons of air conditioning in cooling surrounding atmosphere. This was just one noteworthy statement that came out of an unusual press seminar sponsored by the Jacobsen Mfg. Co. and the American Society of Landscape Architects Foundation. Other speakers stressed that your lawn grass also is important in adding oxygen to the air, that its green color contributes to your peace of mind, and that it helps minimize noise.

How to take care of your chain-saw chains

Does it make sense to install a new chain on your chain saw if the sprocket is badly worn? Not much. A chain costs five times as much as a sprocket. A worn sprocket can damage a chain beyond repair. That's one good fact I learned from a new saw-chain maintenance manual. There are many other good tips in the booklet, a fine guide to team up with the instruction booklet you should have received with your chain saw. The manual is free. Write to Oregon Saw Chain Div., Omark Industries, 211 S.E. Milport Rd., Portland, Ore. 97222.

Revised Sakrete project booklet now available

Want to make some masonry repairs or undertake simple projects that will add value and convenience to your home and its grounds? You'll find help in a revised edition of a 16-page project booklet from Sakrete, Inc. The booklet advises about which mix to use where. You may be able to pick up a free copy from a local Sakrete dealer. If not, send 25 cents to Sakrete, Inc., Box 1032, Dayton, Ohio 45401.

How to install an in-ground lawn sprinkler

A company that makes parts for an in-ground lawn sprinkling system offers an excellent guide for installing the system yourself. Step-by-step instructions include a large sheet of graph paper on which you are advised to map all details of your property as one of the first steps. To order the proper fittings you must know the inside diameter of the water service line running from the water meter to your house. To find this diameter you are told to measure the length of string needed to encircle the pipe and then refer to the table seen below. The guide is available without charge from the Champion Brass Manufacturing Co., 1460 Naud Street, Los Angeles, Calif. 90012.

If string length is:	2¾"	3¼"	3½"	4"	4⅜"	5"
Copper tubing's inside diameter is:	¾"		1"		1¼"	
Galv. pipe's inside diameter is:		¾"		1"		1¼"

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PS Guide to Trailer Brakes

[Continued from page 71]

This kind of adjustment is about the only attention trailer brakes need, aside from normal annual maintenance—pulling the drums, sanding rust off drum, armature, and magnet, repacking the wheel bearings, then putting them all together and adjusting the brakes with screwdriver (or brake tool) applied to star-wheel regulators.

Replacing the "hot shot" breakaway battery usually is done at this time—as well as replacement of worn shoes or magnets. Magnet replacement is as important as shoe replacement; if the magnet face wears down to the coil windings, the result is a dead short and lots of trouble.

Problems in electric brakes. The electrics are capable of being somewhat more troublesome than hydraulic systems, simply because they involve wiring, which accounts for 90 percent of electric-brake problems. Corroded splices, rusted screw connections, and loose crimping can make trouble. There are still diehard trailer haulers who think they can ground a light or brake connection through the hitch rather than through a wired connection—and they sometimes spend hours learning otherwise.

Even wired connections can give trouble if the car/trailer connector corrodes during the off-season. A shot of No-K-Rode or other penetrant-lubricant-conductor will help keep connectors in shape.

Add brakes to a trailer? Generally, the course of least resistance is to replace the entire axle-spindle-hub assembly. Sometimes cost can be reduced by using existing wheels and tires; sometimes existing hubs can be equipped with drums; or the trailer axle may already have flanges to accept brake backing plates.

Grafting those brake flanges on an existing axle is no shade-tree mechanic's project, however. The flange positioning is critical: .015 inch out of line and you have zilch instead of brakes. The professionals have jigs and fixtures to help them. Finding a wheel and rim service shop that has those facilities—as well as a stock of brakes—may take a little research, but the brake companies are eager to help.

Increasingly, those add-on brakes may be disks. They've worked out particularly well on boat trailers because they can throw off water faster than drums. And they provide all the reduced-fade, no-pull advantages that car disks provide. The straight-stopping capability is particularly prized on trailers. PS

Digital Clock You Can Make

[Continued from page 102]

Consult the back advertising sections of electronic magazines for good prices, too. William Electronics Supply, Woodbridge Ave., Edison, N.J. 08817, is one mail-order source. The small, low-current buzzer is available through Projects Unlimited, Siebenthaler Ave., Dayton, Ohio 45405.

It's possible to save $20 by leaving out the IC sockets and the board connector—not a practice we recommend, however.

Setting the clock. S1 is a three-position toggle switch that selects the mode of the clock. S2 is the time-set switch. In time-set position, the clock automatically places the minutes and seconds to zero and displays the hours.

To set the time, press S4 mounted on the hours board. Each time you press it, the hour advances by one. When you've reached the correct time, place the time-set switch back to run position. The clock will then be set to the hour you've selected and at zero minutes and zero seconds. As a verification, the clock will immediately display the hour you've selected, 00 minutes, and finally, 02 seconds. (It took two seconds to display the hours and minutes.)

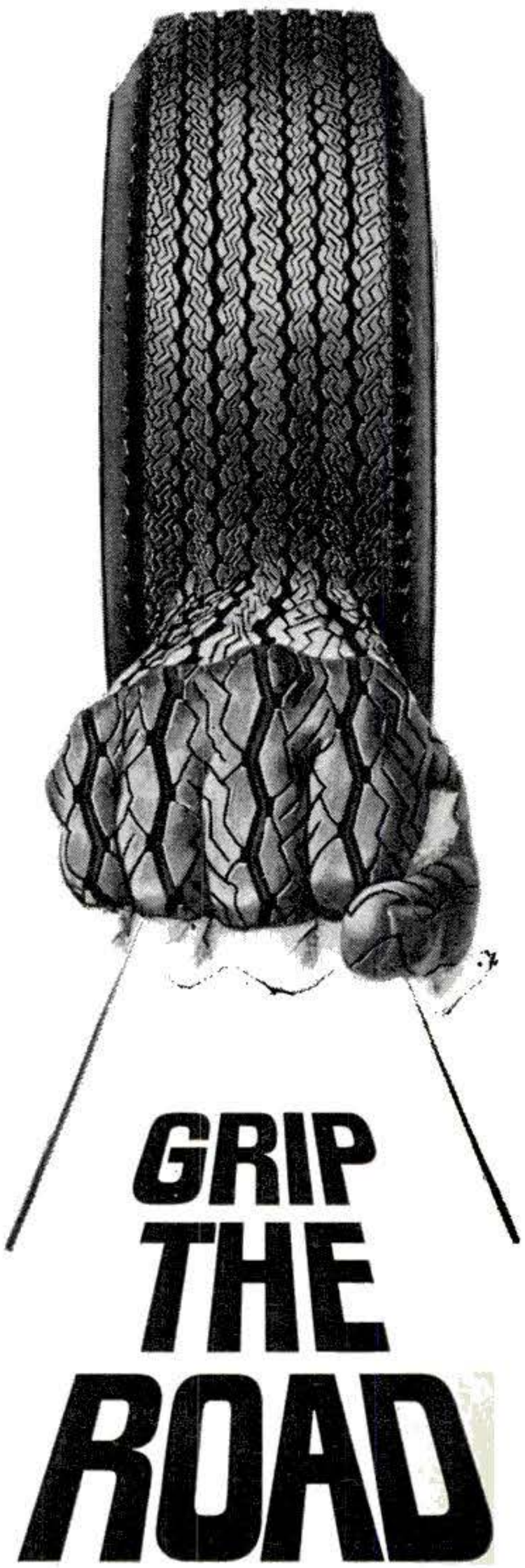
J1, J2, J3, P1, and P2 pin connections (made from the pins of a discarded connector) make your clock more flexible.

J1 and P1 are for connecting the 60Hz line frequency into the clock logic. This can be used as an input of a quartz oscillator circuit if you're bent on precision accuracy.

P2 selects the display time for each scan. Normally plugged into J2, the clock will display the hours, minutes, and seconds for one second each. Plugged into J3, however, the display for each number increases to two seconds—slow for most people's taste, but there if you want it. PS

PARTS LIST

IC 1,2—7-segment decoder/driver, SN7446
IC 3,6—dual JK flip-flop, SN7476
IC 4—quad 2-input NOR gate, N7402
IC 5,20,21,22—dual 4-input NAND gate, SN7420
IC 7,9,11,23—decade counter, SN7490
IC 8,10,24—divide-by-12 counter, SN7492
IC 12-19, 26—quad 2-input NAND gate, SN7400
IC 25—monostable multivibrator, SN74121
S1—DP3P miniature toggle switch (center off)
S2—DPDT miniature toggle switch
S3—SPDT pushbutton (see text)
S4—SPDT pushbutton
D1,D2—7-segment display (MURA DA 133 D)
B—1.8A rectifier bridge (International Rectifier)
T—6.3v @ 1.2A filament transformer (Stancor) P-6134)
R1, R2—680-ohm, ¼w resistor
R3—5-ohm, 5w power resistor
R4—33,000-ohm, ¼w resistor
C1,C2—1,000 ufd @ 15v electrolytic capacitor
C3—0.68 ufd capacitor
Zd—5.1v zener diode, 1N751
Buzz—low voltage/current buzzer (see text)
22—14 pin IC sockets
4—16 pin IC sockets
4—15 pin-board connectors
Miscellaneous: Plexiglas, rubber feet, line cord, vector boards



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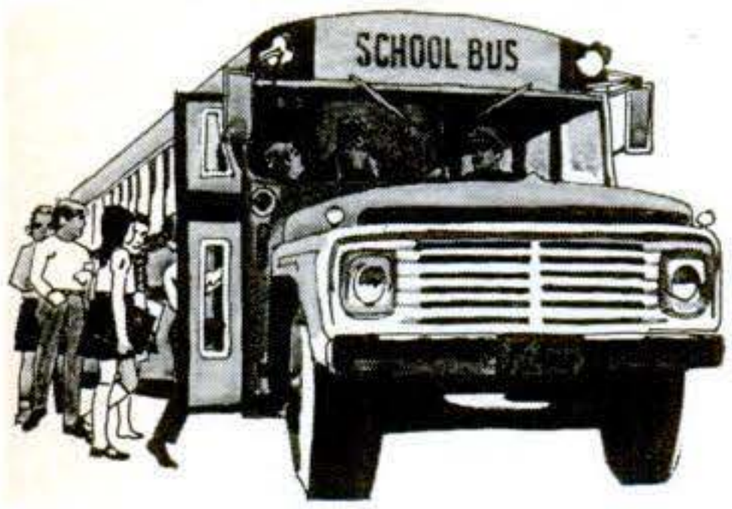

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Those Rugged Inshore/Offshore Fishermen

[Continued from page 91]

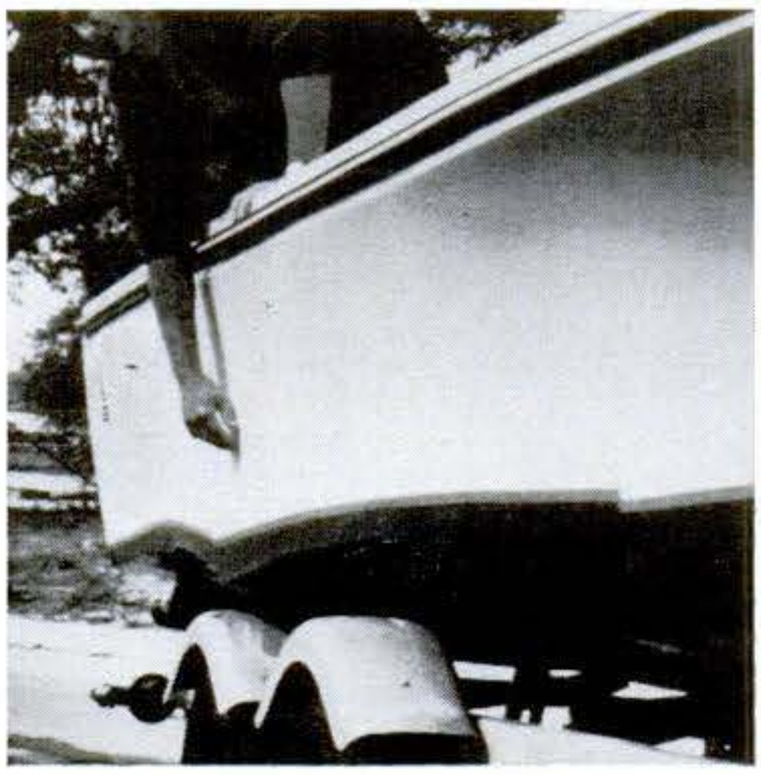
boat with pleasing flair in the cross section, rising at the bow. Above the steering console, if you wish, you can mount a small-scale tuna tower and handle her from dual controls up there. Tower and duals are expensive options, however.

For speed she lived up to her dockside looks. That is, after we pumped her out. Mysteriously, her deep bilges held six to eight inches of water every morning of our test. Since the cockpit drains are unhandily (and dangerously) located above floor level, and this heavy accumulation was below, we had no choice but to man the pump. Months afterward we learned why. She was sent back to the factory, where it was determined that a workman had drilled holes through the flotation and right through the bottom. It could have happened to any brand of boat, of course.

Less easy to fix was its tendency to pound and take in lots of water over the bows in a chop. At certain headings in the Gulf Stream, we climbed to the tower for steering to avoid getting soaked. In addition, her lightweight bow tended to wander in the wind. Word from the factory is that some remodeling has been done to cure this wet performance.

Roballo 19. Five feet shorter, and equipped with twin 65-hp Evinrudes, the Roballo did just about everything right. Her good lines are finished off with rope rub rails. She's fitted with a plastic no-frame windshield, which puts no bar in your view, and visibility is excellent. However, this means no windshield handhold in rough seas, either.

The Roballo gave a dry and comfortable ride in every choppy condition we encountered. And she has a genuine self-bailing cockpit, with two large scuppers in the transom capable of drawing off large quantities of water rapidly. Everything about this boat is solid, thoughtfully planned, carefully crafted.



Tridyne's stepped hydroplane hull was designed by marine architect Bob Hobbs.

Wellcraft 20. The Step-Lift V designs by this maker have longitudinal strakes to help the boat rise to plane under power and a step in the bottom toward the stern to reduce drag.

These hulls are said to be almost impossible to broach in a following sea. Ray Hunt—the same man who *invented* the deep V—designed them. A wide flaring bow helps keep you dry, and the chine with flat steps helps reduce roll. A solidly mounted rail on each side and across the top of the windshield gives a good safety handhold in rough water.

Two Makos. We tested a 17-footer with single 85 and a 19 with 100-horse Evinrude. There was no measurable difference in performance, though for some reason I enjoyed the 17 more. The 19, with deeper bows, will ride through bigger water, of course. These are taut ships, well-equipped and immaculately finished. Fuel tanks are built into the bilge directly beneath the control console and are surrounded by a layer of fire-retardant foam. A forward-facing seat is built into the front of the console.

Starcraft 21. Want a *10-man* fisherman? The maker says the aluminum Mariner fills the bill. To take a look at this one, we journeyed north to Milwaukee. It's a true offshore fishing boat. The 21-footer weighs only 875 pounds empty; has a carrying capacity of 2,000 pounds. Power rating goes to 140 hp. Lapstrake design is formed in the aluminum hull.

Tridyne 22. Our third testing location was north of Orlando, Fla. Here naval architect Bob Hobbs has made some changes in the underwater configuration of the modified-V hull. The result is a stepped hydroplane form. He calculates this will give the Tridyne an advantage of 11 to 15 percent over comparable hulls, reduce pounding in rough seas, and give it a more level attitude during acceleration.

Our tests with the Tridyne were in mirror-smooth waters. We had a companion boat of the same design but without the stepped configuration. In a long-distance, high-speed run, the Tridyne pulled away from the conventional hull at just about the rate Hobbs claimed for her. Maneuverability and control are excellent.

It's no wonder these boats have become popular far and wide. There are many others; and we were sorry that our schedule didn't allow us to test them. PS

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Surfboard Conveyor

[Continued from page 82]

is pumped straight through the tubes. Direction of travel is reversed by blowing air the other way. The system requires no lubrication and is almost silent.

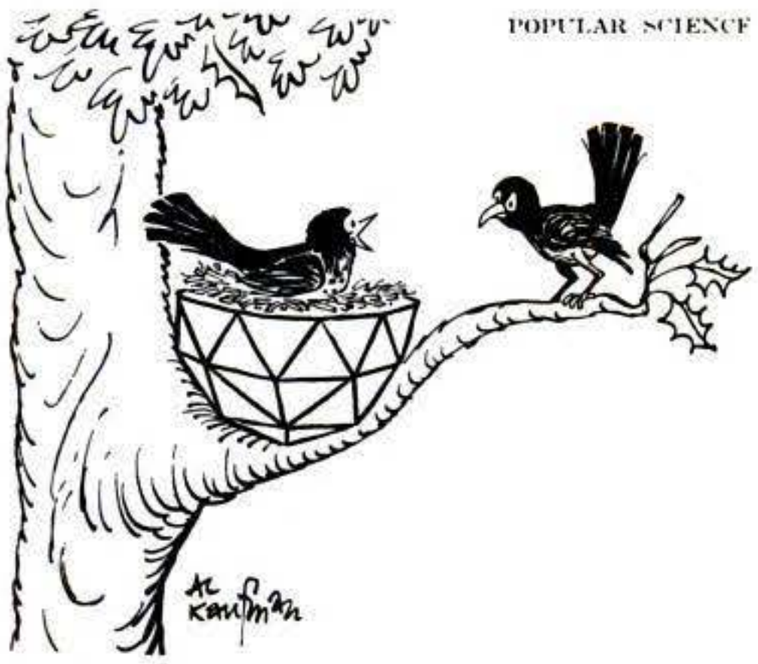
Changing lanes. A working model in John Spillman's lab at Cranfield's Department of Aerodynamics shows a loop circuit in action. Two overlapping U-formed tubes, fed individually with air of different pressures, causes the speed to differ over the two lengths. A pair of laden caster-steered trolleys chase each other around in a fast/slow sequence, but never catch up. The loop has a gentle slope at one end, and an inner bend of slatted track with a switch arrangement.

Another demonstration model is a sled-like carrier traveling on a line of captive rollers whose axles are lifted in wave-motion by the inflated tubes below. The simple load platform tilts forward as it moves, and is propelled by a combination of gravity and the wedging action of the rollers thrusting against tapered runners.

Looking beyond the lab. Spillman sees his surfboard concept as an underground transport system in mines where air operation eliminates the risk of explosion, for moving cars through tunnels without exhaust pollution or the hazards of mechanical breakdown, or as a factory conveyor, where stationary floor-level tracks would not impede cross-traffic.

Since movement of the carriers depends on loading to flatten and seal the tubes, the system could be developed as a personalized travelator at airports, railroad stations, or department stores.

You'd actuate individual platforms just by stepping on one, then halt it at your destination by stepping off. Localized speed regulation would allow slow-motion track sections at stations for alighting or boarding, with fast runs in between. PS



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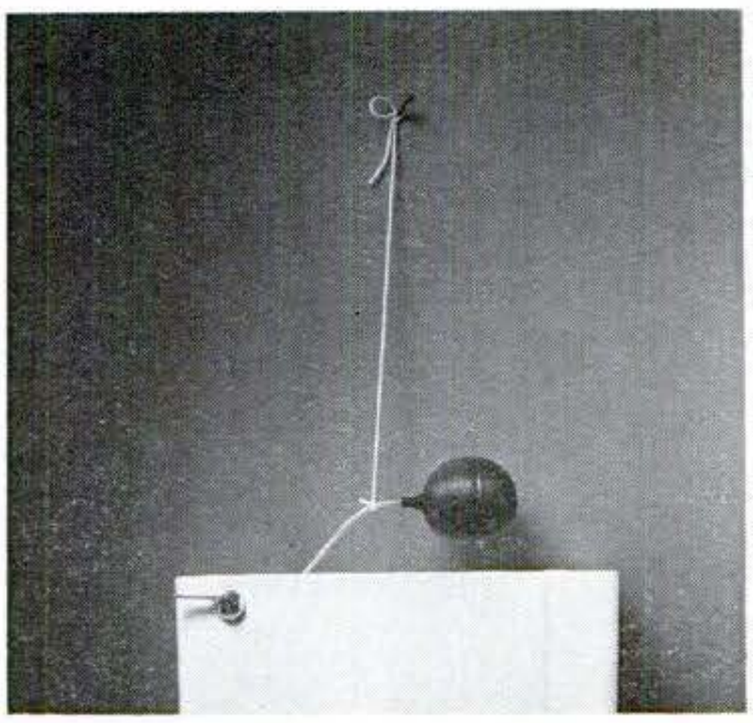

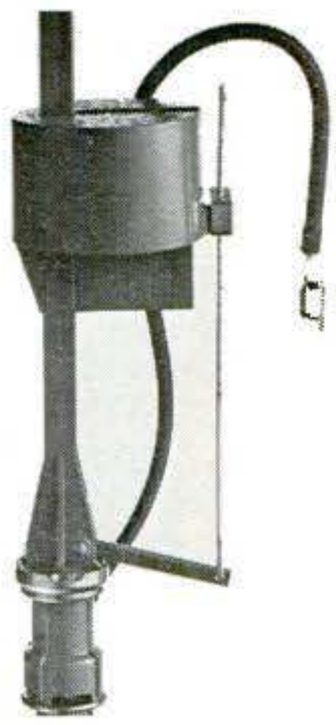

Two ways to stop toilet noise.

Leaks. Squeaks. Whines. Whistles. Ever try to live with the sounds of a leaky toilet ballcock? Some people do.

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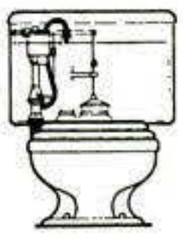

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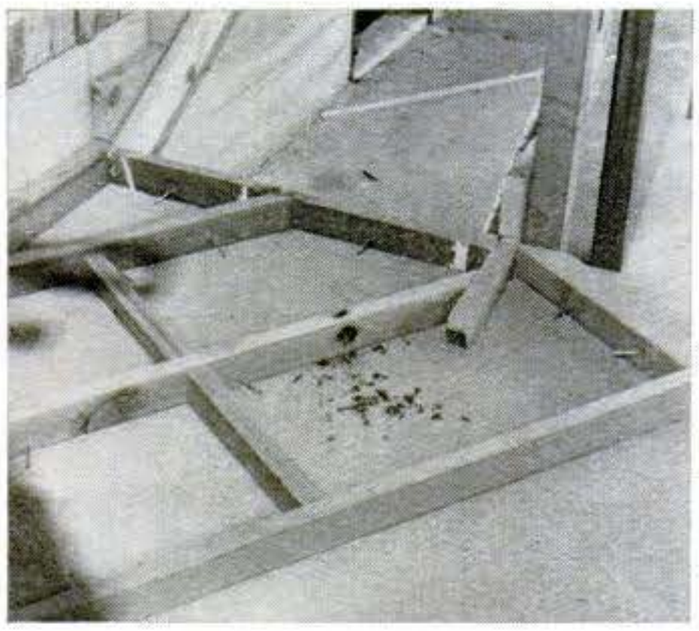


Wood step on concrete

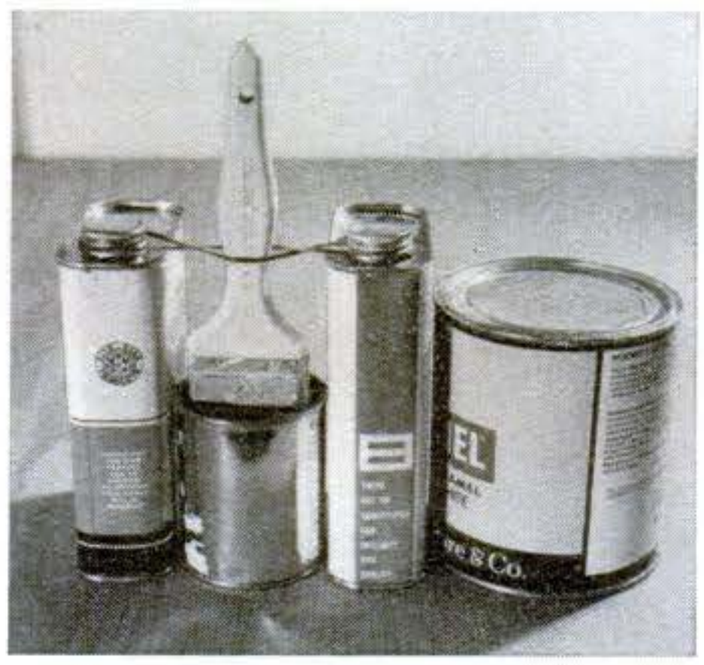
When I added a small deck to the house, I had to raise the landing to keep step relationships in order. It had to be wood, so I had the problem of attaching to the existing concrete. Solution: Make a wood frame to provide nailing surface for the deck boards, stud the inside faces with 16d galvanized nails, and then fill with concrete. This "foundation" is solid, permanent, and nonsqueaky.

R. J. De Cristoforo
Los Altos Hills, Calif.

Sandpaper cutter

Cut the metal saw edge from an empty waxed-paper box, tack the strip to a piece of plywood with the saw edge overhanging a bit, and mount the assembly at a corner of your bench to serve as a handy sandpaper cutter.

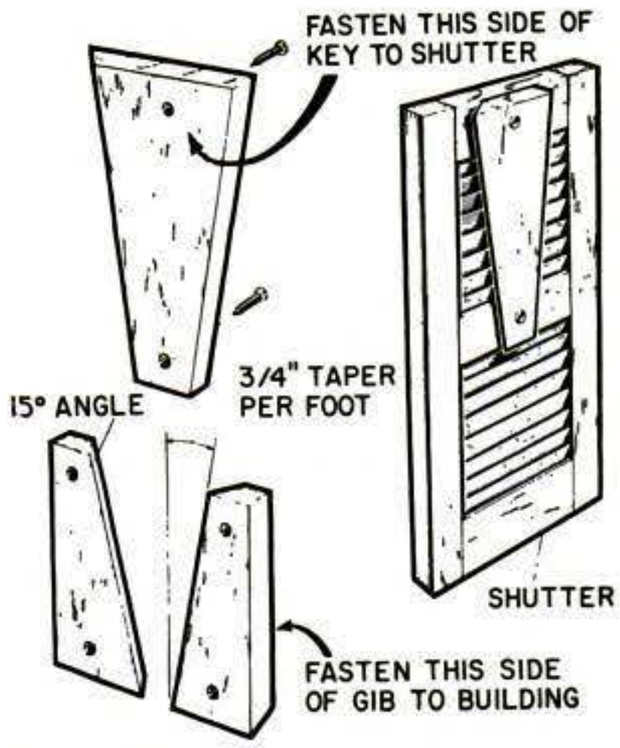
J. Marshall, Newburyport, Mass.



Paintbrush holder

Make a quick holder to suspend a paintbrush in thinner or turpentine by stretching a rubber band between two thinner-can tops. With just two twists of the rubber band, you can place it around the can tops and the brush handle, then adjust the brush to the correct depth. If either can is low on thinner and too light to hold the brush, shore it up with a can of paint, as in the photograph.

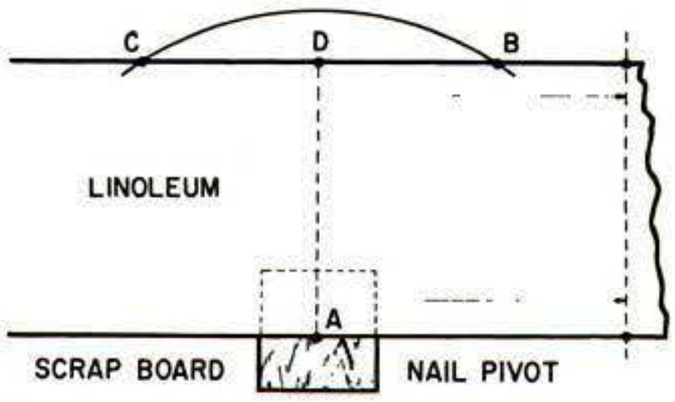
W. B. Sill, New York, N.Y.



Slip-off shutter mount

I've found this setup makes removing decorative shutters for cleaning and painting easy. Attach gib to the wall as shown, and fasten the key to the shutter. No unsightly locks or nails are visible when the shutters are in place. Removing them requires only a blow from the bottom.

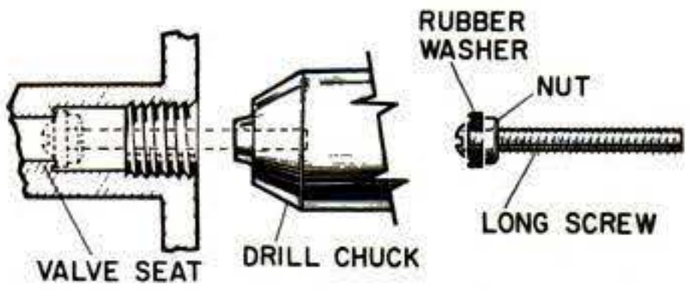
W. E. Tritz, Waukesha, Wis.



Squaring wide material

Slide a piece of scrapboard with a nail in it under the material and tie a string to the nail with a pencil attached. Mark arcs at B and C. Draw a line from D (center of BC) to A, and transfer this line to the edge.

Elwin Trump, Wymore, Nebr.



Easy faucet repair

If your faucet is leaking, inspect the washer and valve seat. The seat should be smooth and without nicks or corrosion. Correcting a faulty seat is easy. Fasten the washers, reversing their normal seating position, with a nut on a 1½" to 2"-long round-head screw. Chuck this assembly in a hand drill with a little lapping compound on the washers. I've found that applying this to the valve seat very quickly makes a perfect seat.

C. W. Floss
Grosse Pointe Park, Mich.

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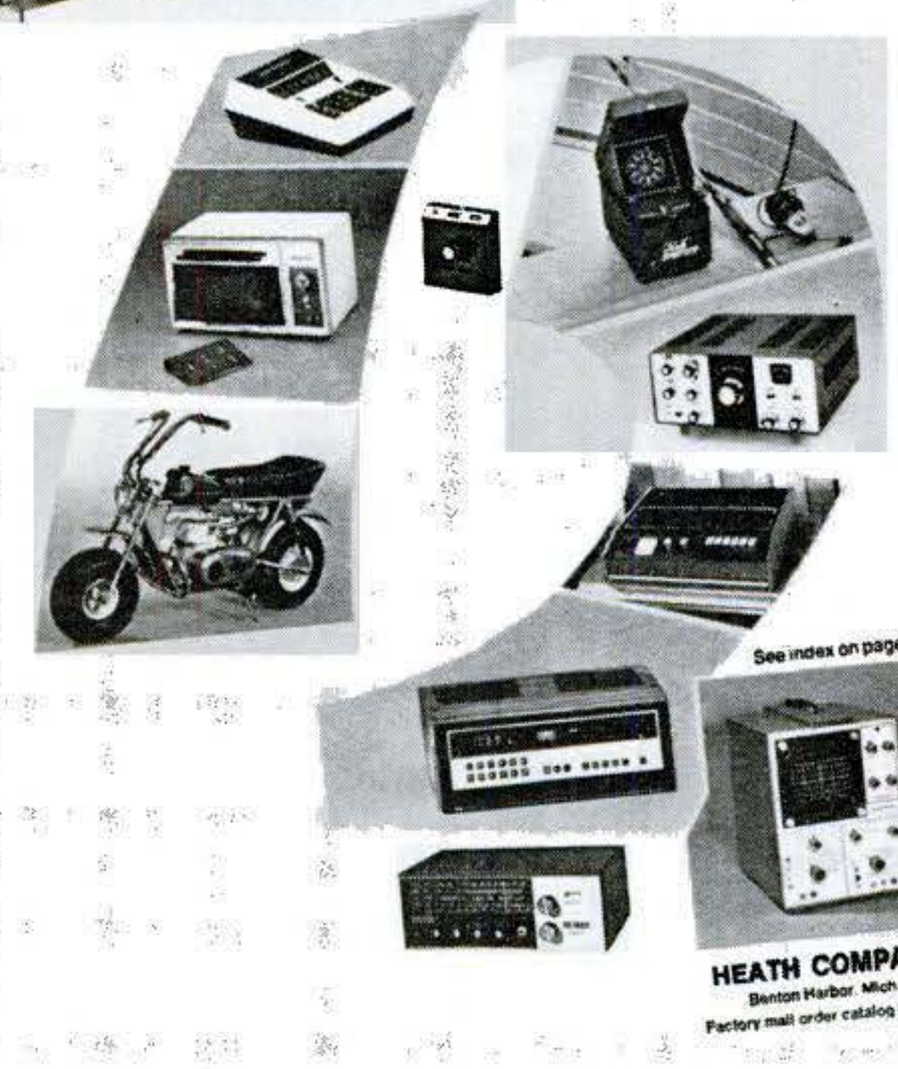

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National Hunting and Fishing Day,

Sept. 23, 1972,

may be the most important day in the lives of 55 million hunters and fishermen.

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Every hunting, fishing and conservation club in America is being asked to hold an OPEN HOUSE for the public, to dramatize sportsmen's contributions to conservation and to introduce the public to outdoor skills.

National Hunting and Fishing Day officially recognizes the role of America's sportsmen in conservation and outdoor recreation. Resolutions now in Congress not only establish NHF Day, but ask hunters and anglers to lead the public in a rededication to the conservation and respectful use of our wildlife and natural resources. Your sportsmen's club should take the leadership in your community by holding an OPEN HOUSE which shows your friends and neighbors what sportsmen are doing for conservation . . . and have done for the past 70 years.

Open House can win new friends for conservation and introduce youngsters to shooting and fishing. No one can do more for hunting and fishing than you, working in your own community on a friendly person-to-person level with your neighbors and business associates. By helping your sportsmen's club organize an OPEN HOUSE, you could show exhibits and movies about the sportsman's outstanding contributions to conservation to many new people. You and your club can set up skill centers for young people and their parents to participate in shooting, archery, casting and camping . . . really show them what goes on at a sportsman's club and how much fun it is. It's an ideal time to teach them that the American sportsman is the best friend fish and wildlife ever had. An OPEN HOUSE might also be used to raise funds for a conservation project with a turkey shoot or casting game. Civic leaders will be glad to provide valuable support, and you might well get a newspaper or broadcasting station to co-sponsor OPEN HOUSE. National Hunting and Fishing Day, along with state proclamations by all 50 governors, will help get publicity for your role as a sportsman in conservation. Imagine what will be done when clubs like yours hold successful OPEN HOUSES all over the country on National Hunting and Fishing Day!

You'll be supported by these important organizations:

- National Wildlife Federation
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- Wildlife Management Institute
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- The Wildlife Society
- American Fisheries Society
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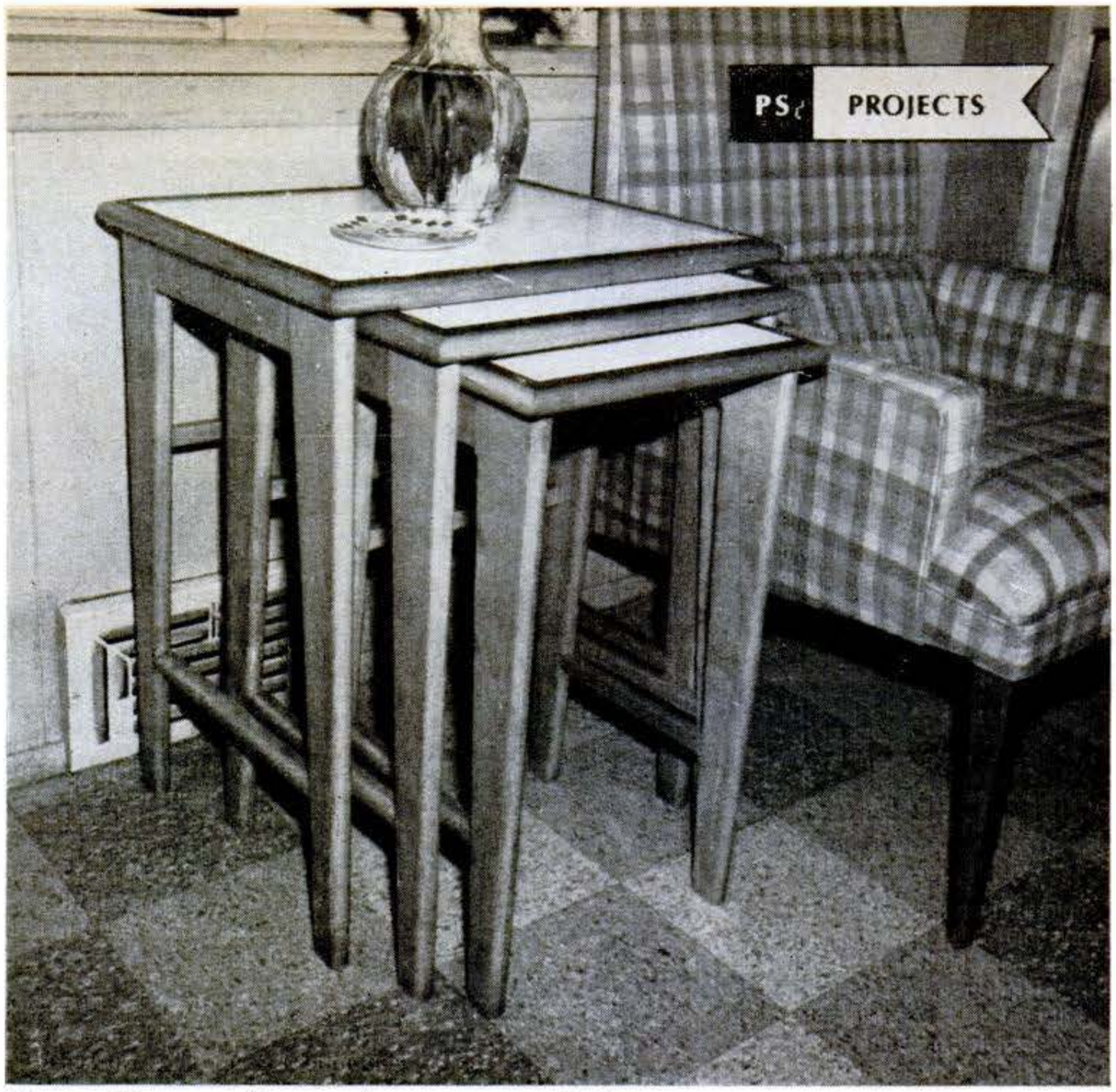


Three tables store like one between use. All three are strong enough to use as seats.

Make a Trio of Sturdy Stack Tables

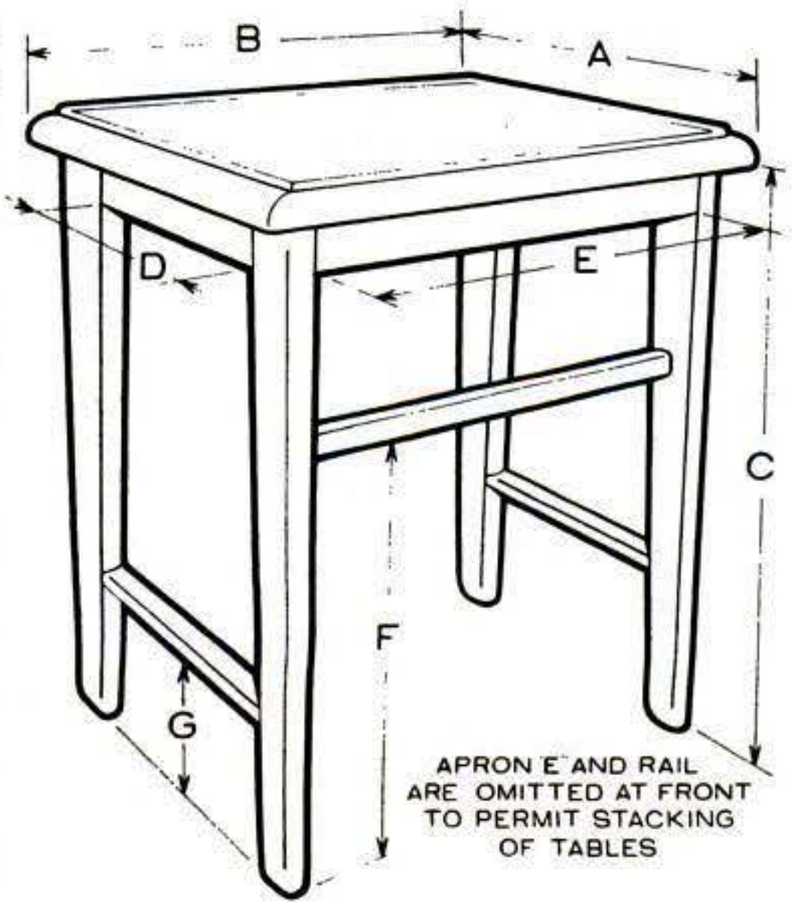
The $75 price tag on a trio of stack tables I saw in a furniture store sent me home with a resolve to make my own set. As it turned out, I saved $65, and I ended up with sturdier tables than those in the store.

The tops are plastic-laminate sink cutouts (a local cabinet shop will often sell you these at low cost). Birch 1-by-3 (36′), 2½″ screws (21), and glue complete my materials list.

The drawing and accompanying table show the dimensions I used. All the spreaders and top edging pieces are made from ⅞″ strips ripped from the birch, and routed half-round. All legs are 3″ wide at the tops. Starting two inches down from the top they taper to 1½″ at the bottom. All rails are 2″ wide.

Join legs, rails, and spreaders, and glue and screw the unit in place—three screws through the back rail, and a pair through each side rail.

The finish is up to you. I used rubbed varnish, but a careful multi-coat enamel job—sanded lightly between coats—gives you a nice oriental-style finish.—*Harry Sherman*



Dimension	large	medium	small
A	15¼″	13″	11¼″
B	19¼″	15″	11¾″
C	24″	23″	22″
D	9¾″	7¾″	6⅜″
E	17¼″	13⅜″	10⅛″
F	6″	6″	6″
G	15¼″	14¼″	13¼″

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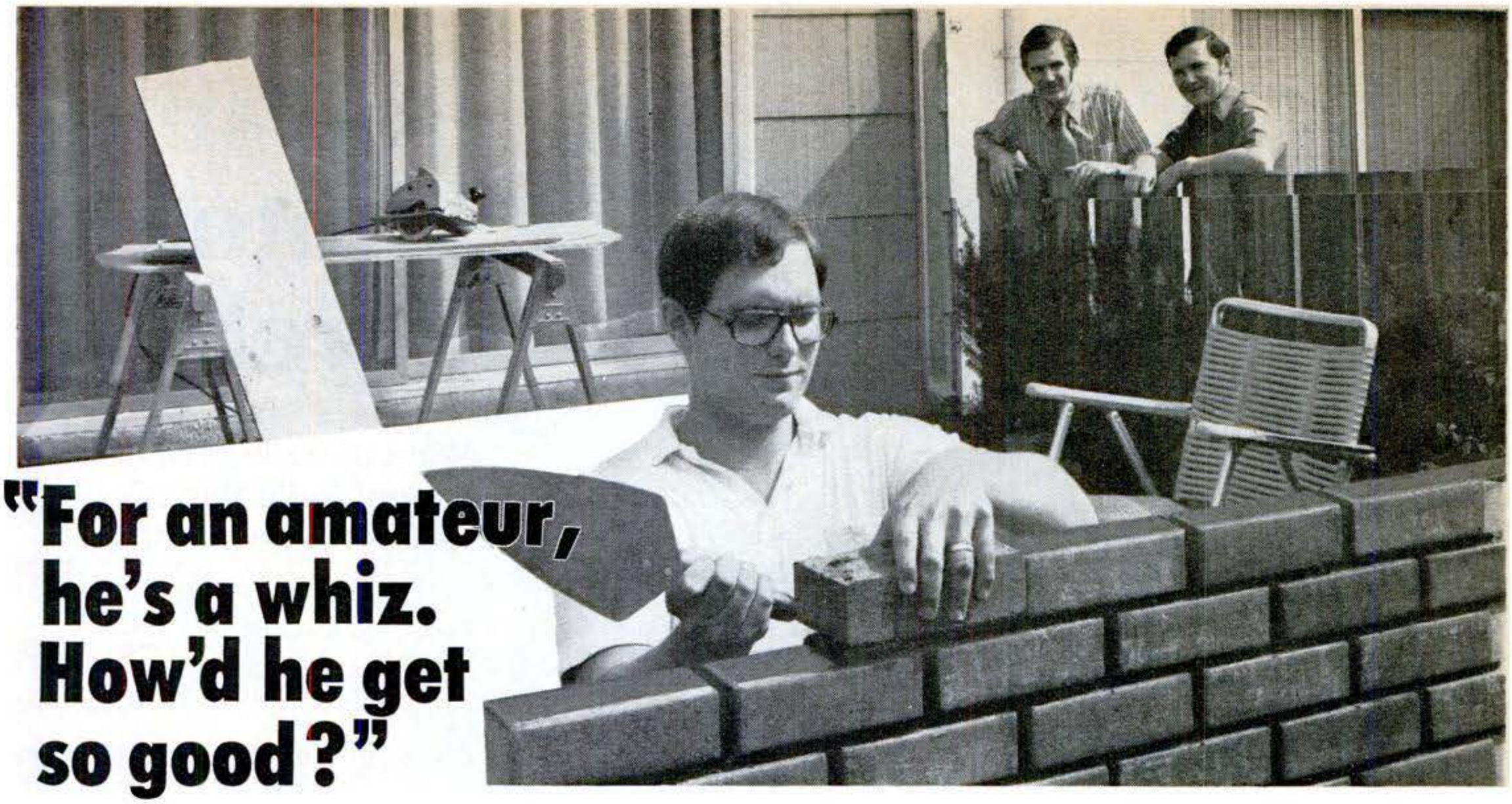

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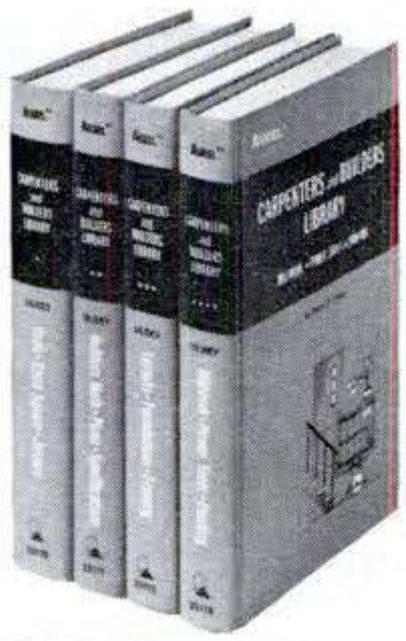

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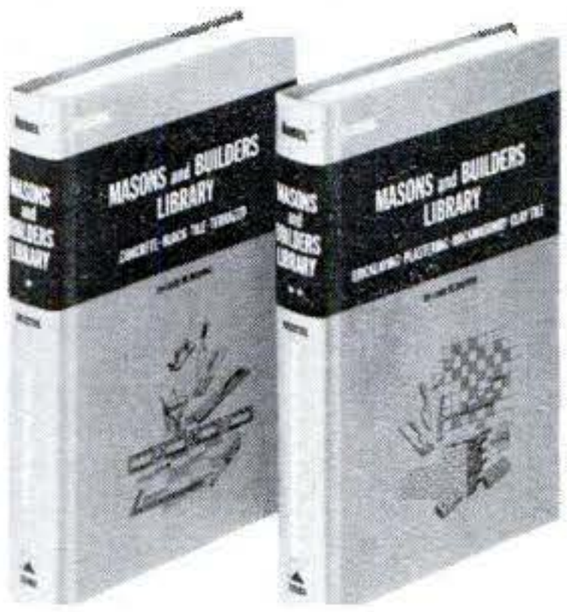

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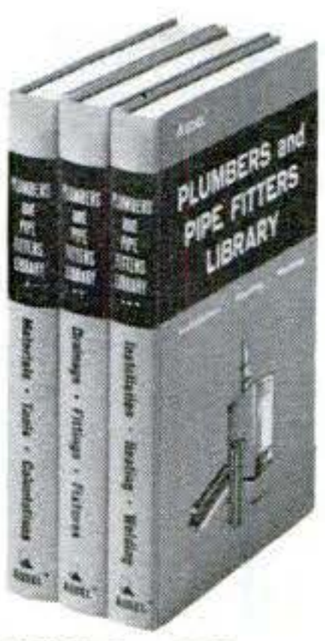

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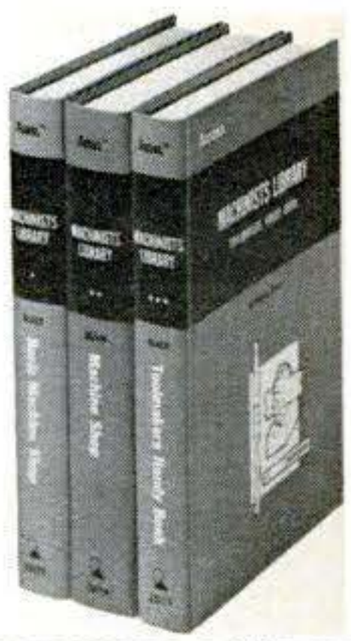

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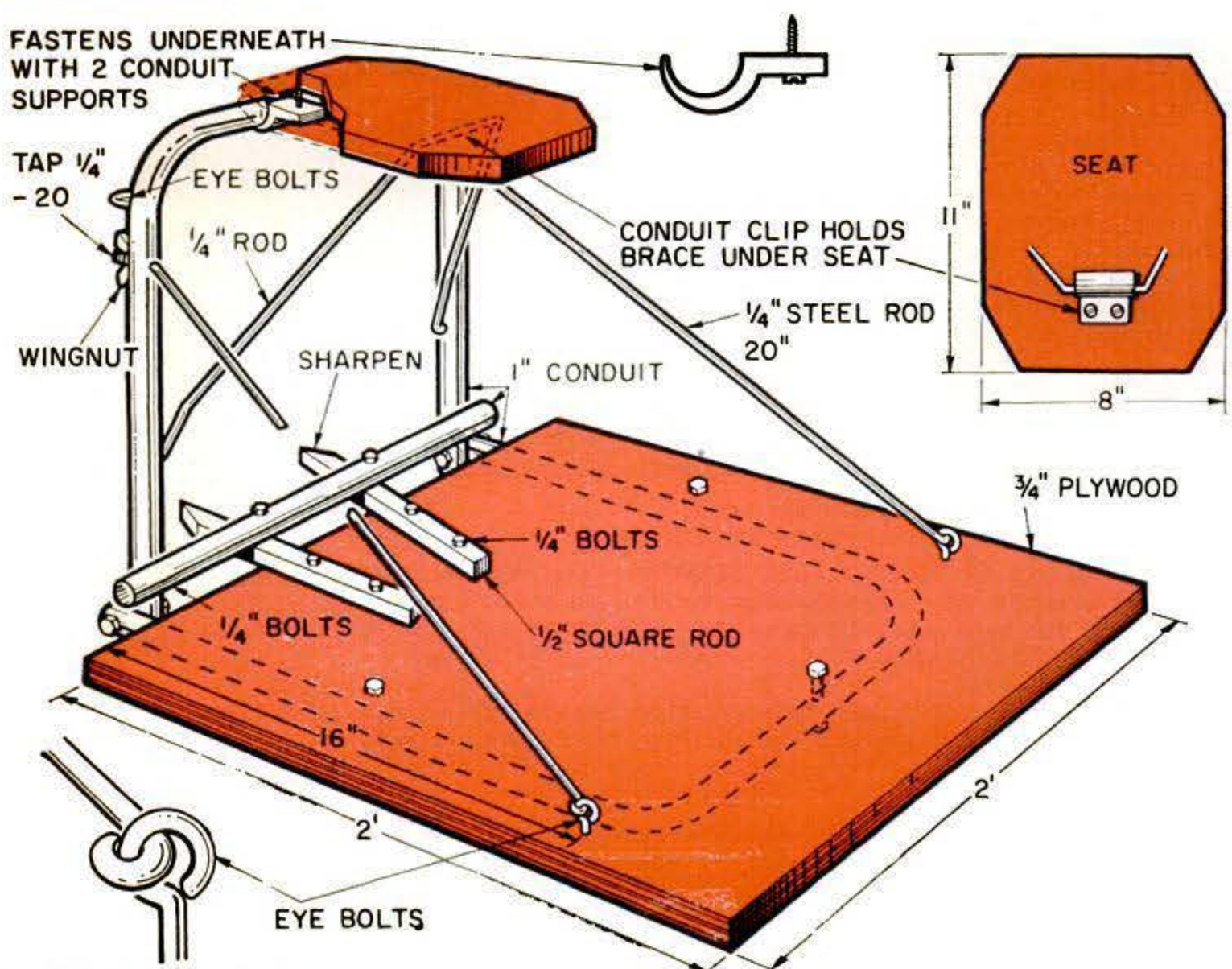
Bird's-eye view of the birds—that's what you get from the seat of the perch. Great for hunting as well as photography.

Getting to the top is easy, as shown in three-photo sequence at left. Rope ladder and throw line (detailed on page 145) get you to a convenient branch, then you pull the perch up behind and strap it in place. Sharpened spurs (see sketch below) dig into tree trunk and give seat a safe, firm grip when support belt is drawn up tight.



Portable Photo Perch

Want to really get back to nature? Build this private lookout in the treetops

By J. C. SPANGLER Sr.

Ask any successful wildlife photographer the secret of getting good pictures. He'll tell you it's getting close to your subject. One of the best techniques I've found for getting close to birds and other animals is to work from a tree perch. A few years ago I used to cobble up a perch by lashing and nailing limbs in place in a convenient crotch. But these perches required a lot of work and constant maintenance. Every time I wanted to move to a new location it meant building another from scratch.

A bone-jarring fall from one of these makeshift tree houses convinced me there must be a better way to work in a tree. I needed something stable, yet portable enough to move from place to place without disturbing the natural surroundings. The final result is this photo perch.

It can be collapsed for transport, or extended for use in minutes without need for any tools. The support belt not only holds the perch in a tree, it lets you strap it to your back like a pack. For most photo projects, one perch is enough. But sometimes I use a pair—one for me, and one for my equipment.

Putting it together. The sketch at left shows how to make the perch. Not shown is the support belt. It's nothing more than an ordinary auto seat belt with its hooks anchored to eyebolts in the seat support.

If you work with long lenses you'll probably want some kind of camera support to steady your rig when you shoot. I adapted an ordinary panhead monopod for this purpose. Its bottom end fastens to a stiff coil-spring mount of the type used to secure a whip antenna to a car. This spring mount, screwed near the front edge of the platform, is steady enough for sharp pictures, but its flexibility lets me follow action quickly. There's

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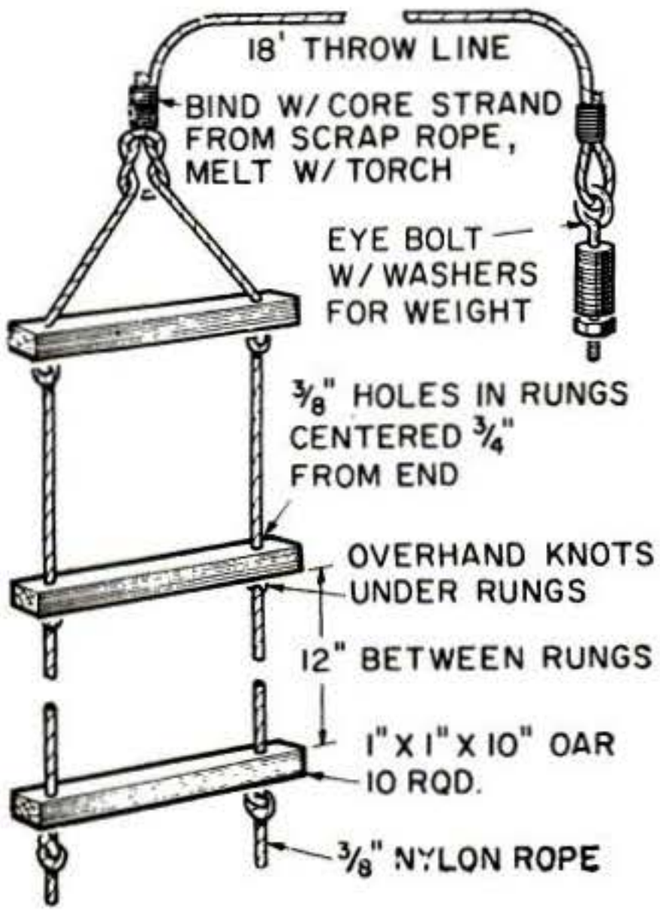
another advantage too. With this type of mount there's no danger of knocking your camera over the side.

Getting up in the tree. There are a number of ways to do this, but here's the technique I like best: Pick your tree, and throw the weighted end of the rope ladder over a limb at the right height for the platform. Pull the rope ladder up so its top rung is about two feet below the branch. Then holding the rope in one hand, the ladder in the other, spread your arms wide and spin around two full turns. This will twist the line up tight under the branch. Throw the weighted line over the branch again, and repeat the spinning operation. Keep doing this until the ladder will support your weight without slipping.

Now tie the end of the weighted line to the perch and climb the ladder. When you're firmly situated on the branch, pull the perch up with the weighted line. Place the perch against the tree trunk where you want it. Pass the support belt around the tree, fasten the buckle, and pull it up tight. Push down on the front edge of the platform to dig the spurs into the tree trunk, and climb aboard. I've found the perch works well as is, but if you're after extreme closeups of wary species, consider improvising some sort of a fabric canopy to cover the perch like a blind.

Safety precautions. 1. Use a safety line attached to your waist and to the tree. 2. Don't wear meter or camera straps around your neck. Attach them to your belt. 3. If you feel yourself getting drowsy, get down or fold up the seat and sit on the platform itself. Shorten the safety line to restrict your movement.

Follow these precautions and you'll spend many relaxing hours watching and photographing wildlife patterns you'd never see from the ground. Sit very still and you may even find yourself sharing your perch with a friendly chickadee. PS



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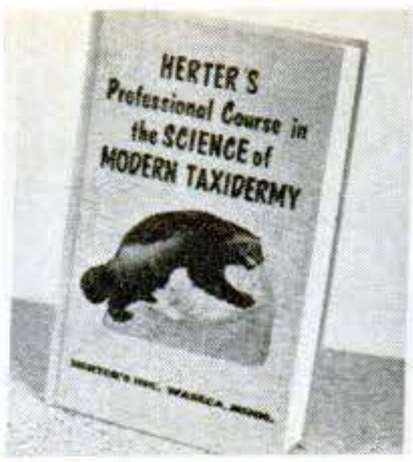

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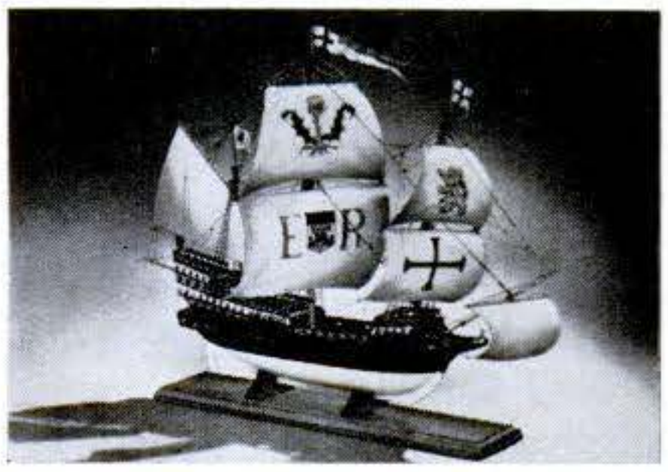

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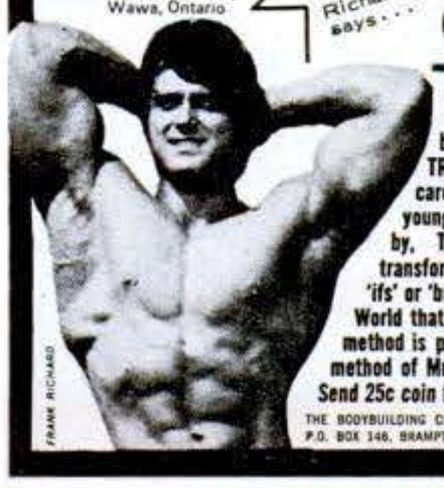

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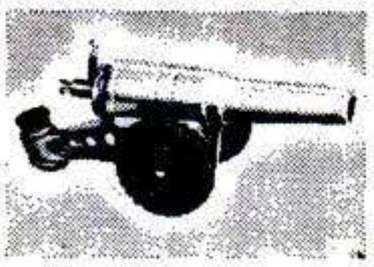

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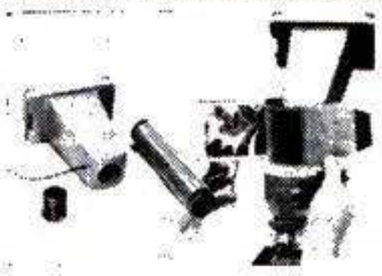

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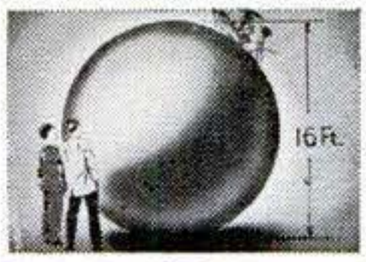

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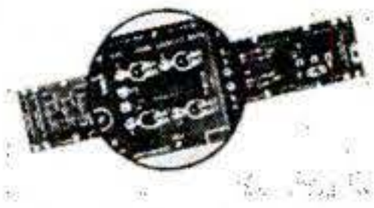

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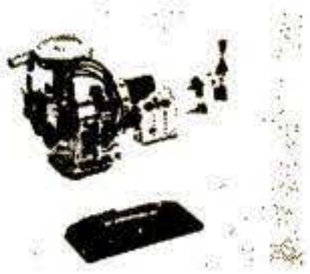

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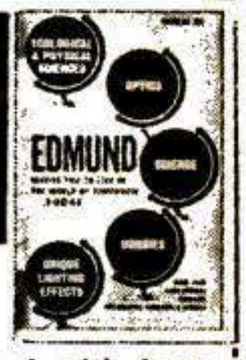

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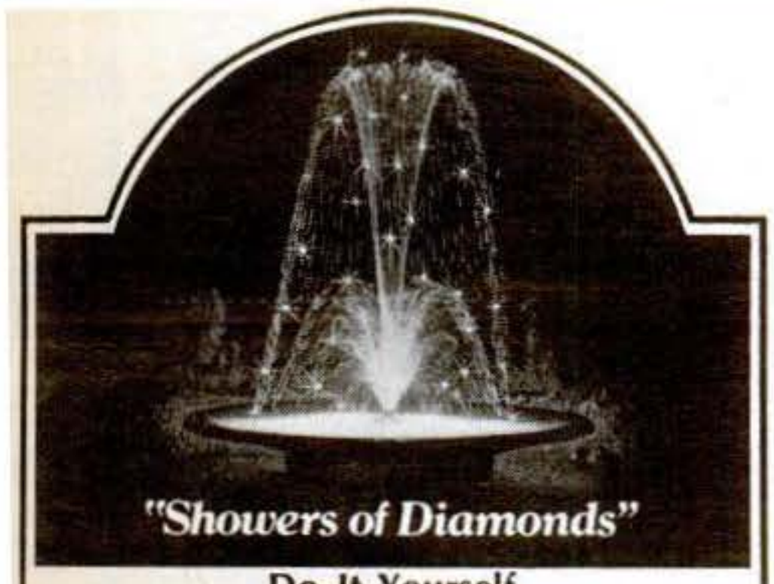

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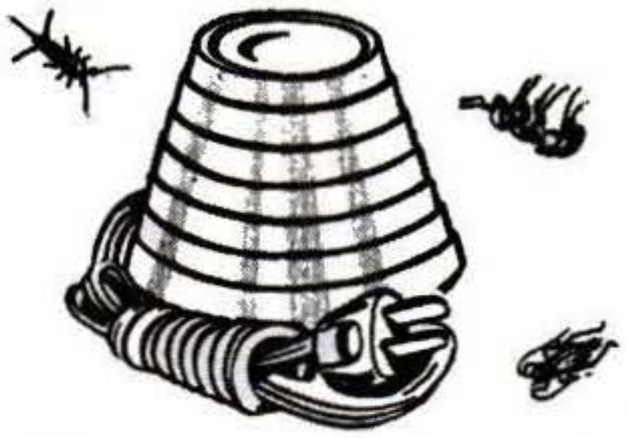

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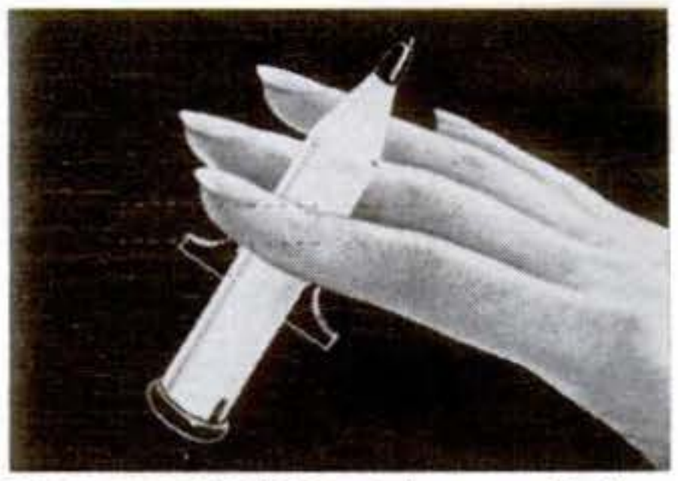

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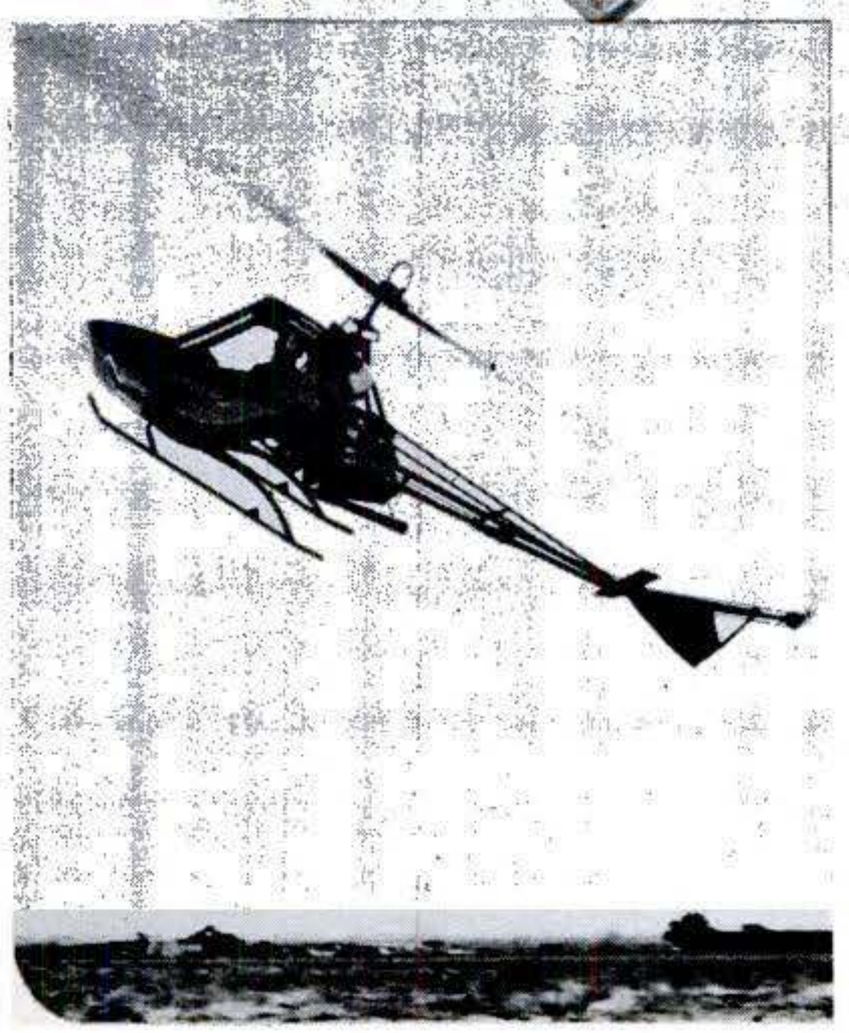

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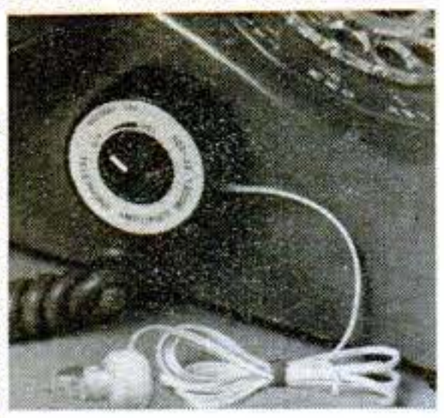

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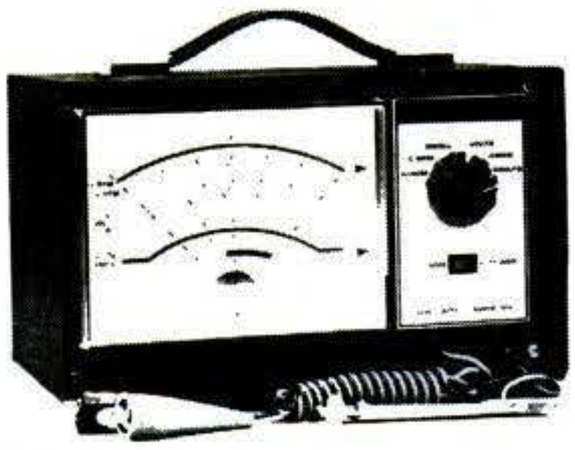

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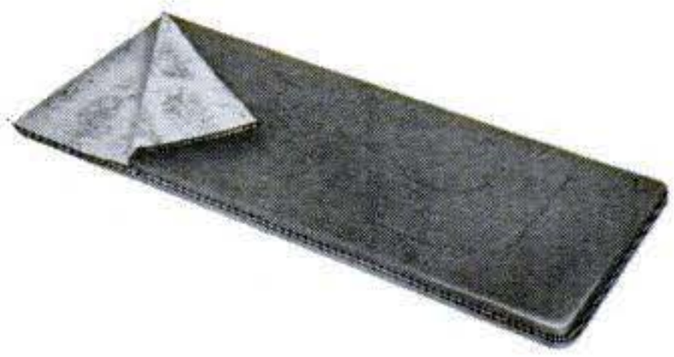

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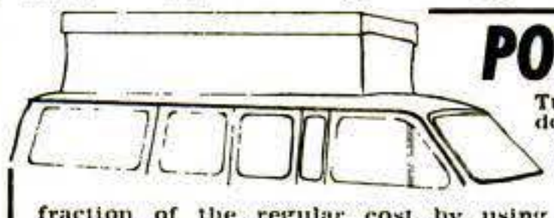

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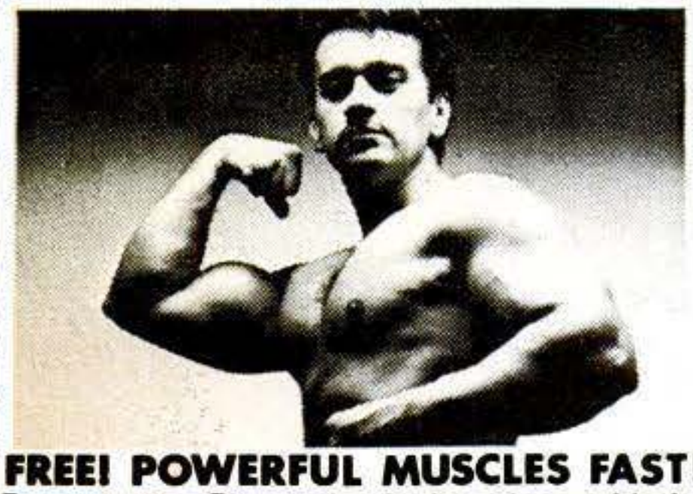

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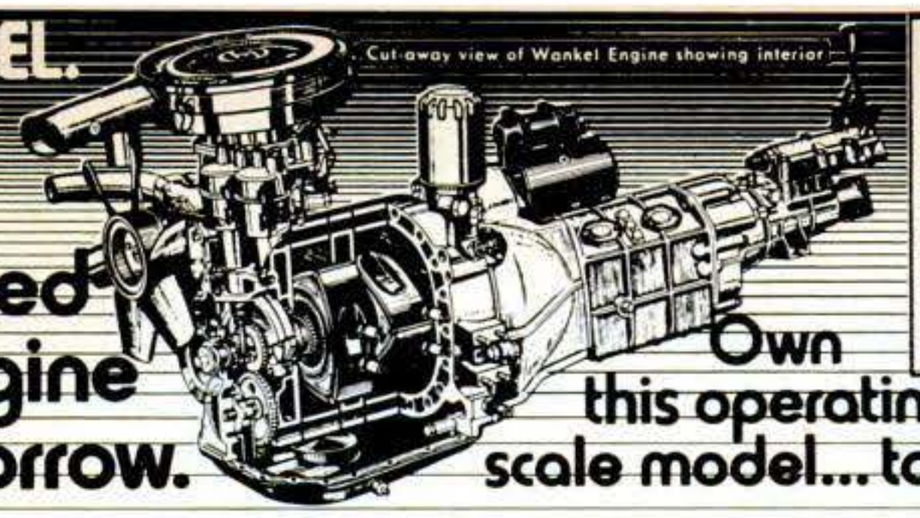

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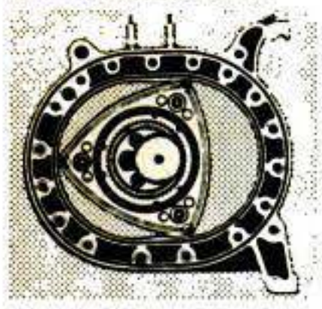

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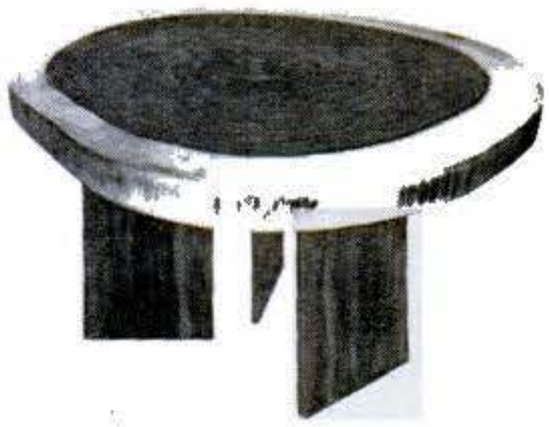

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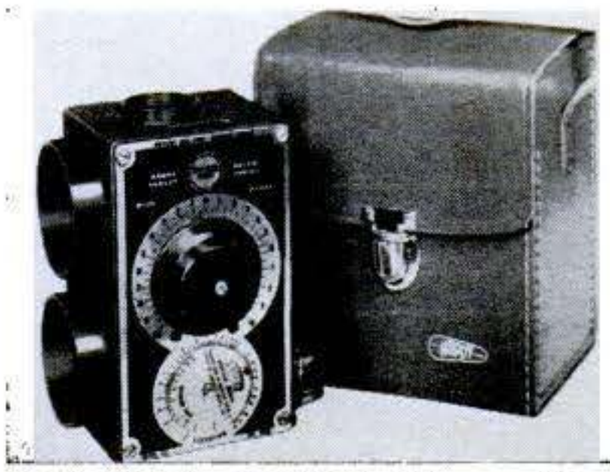

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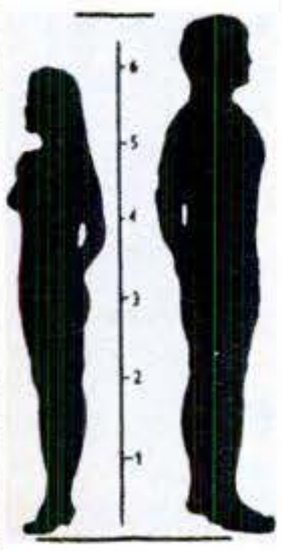

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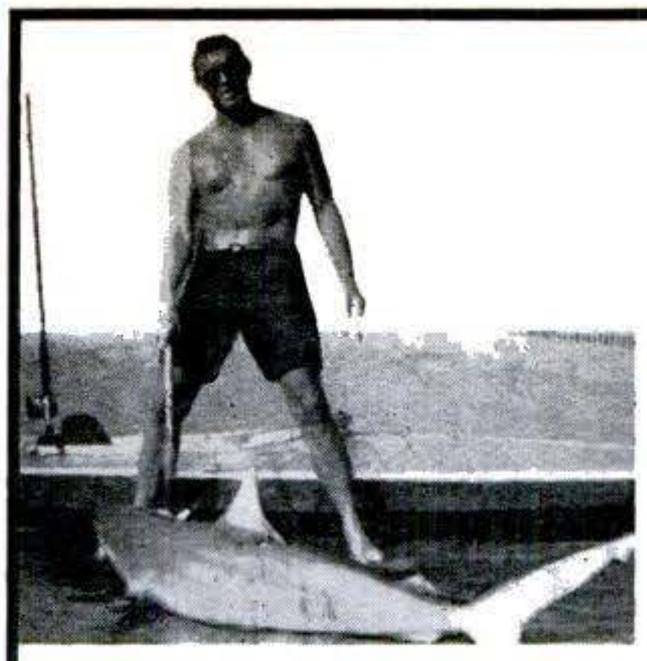

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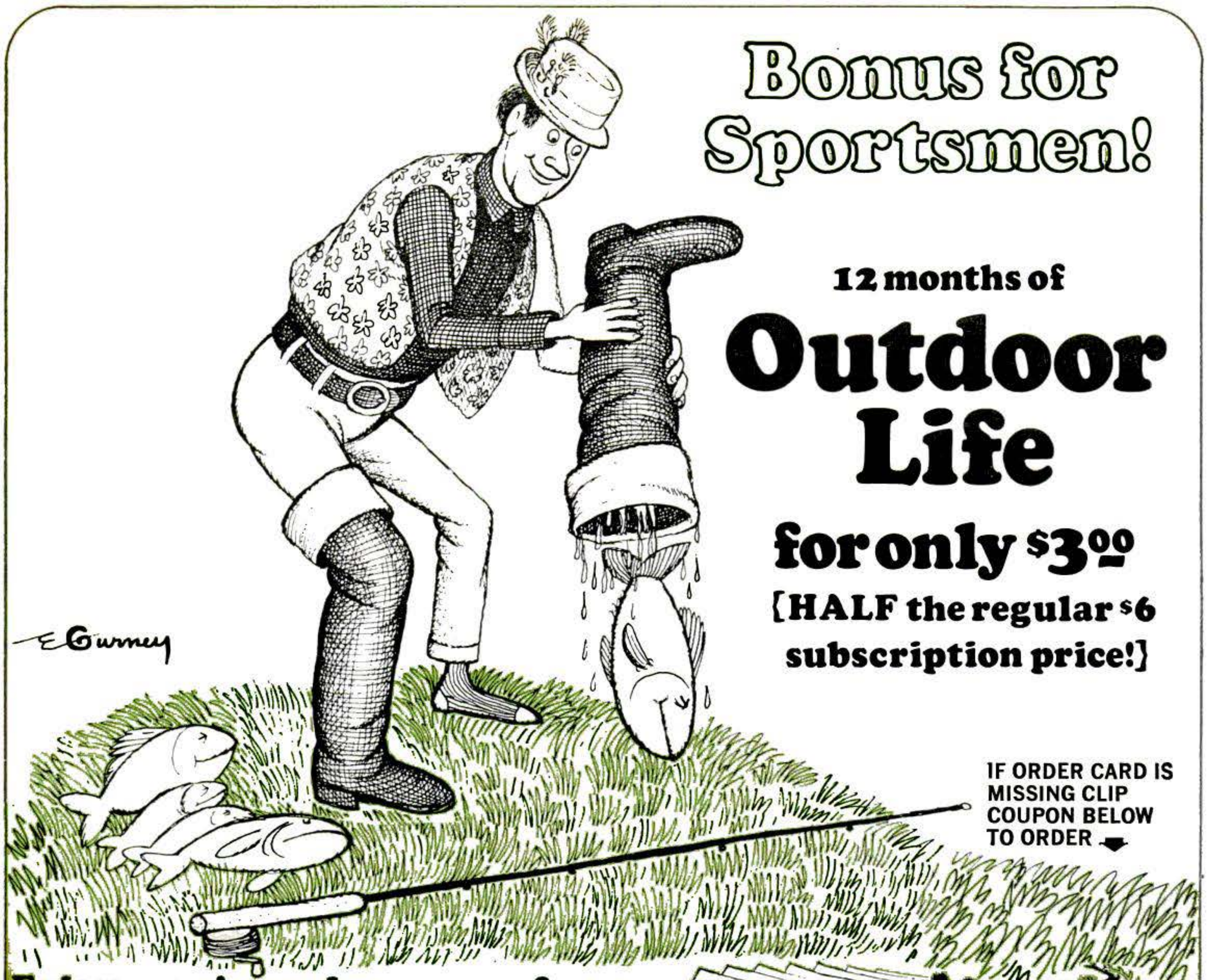

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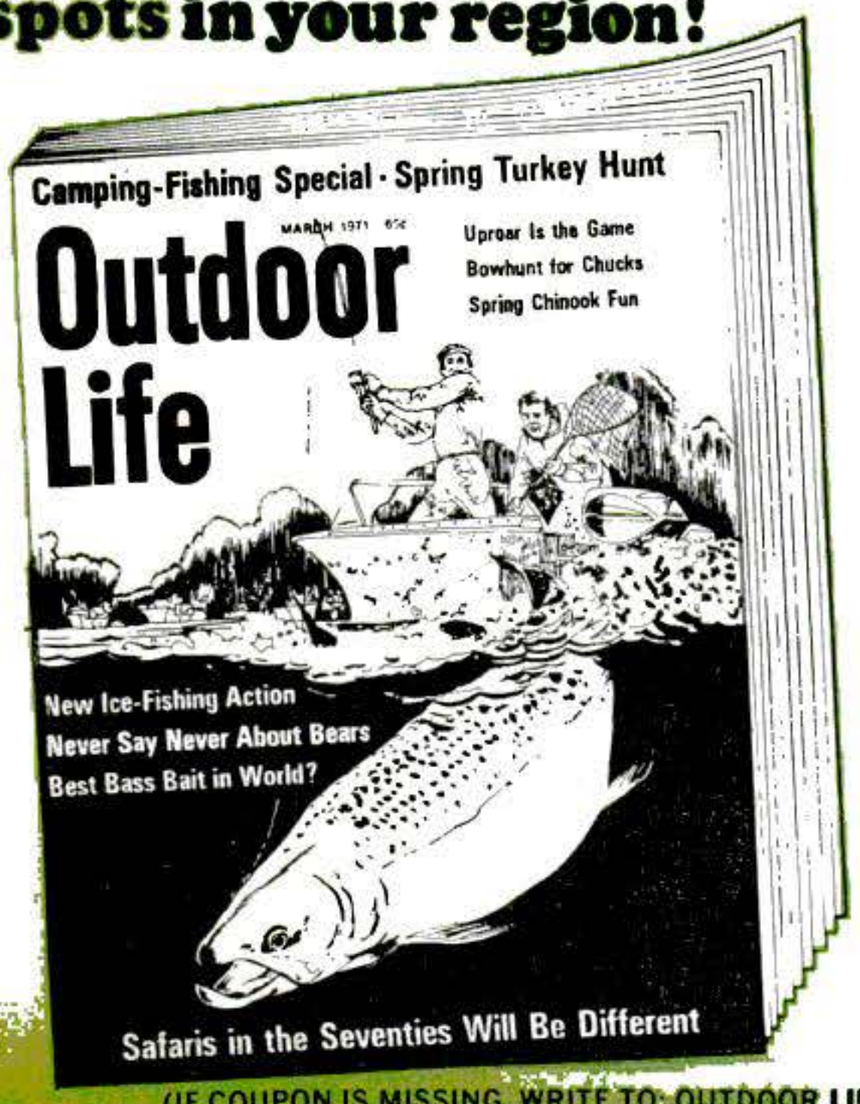

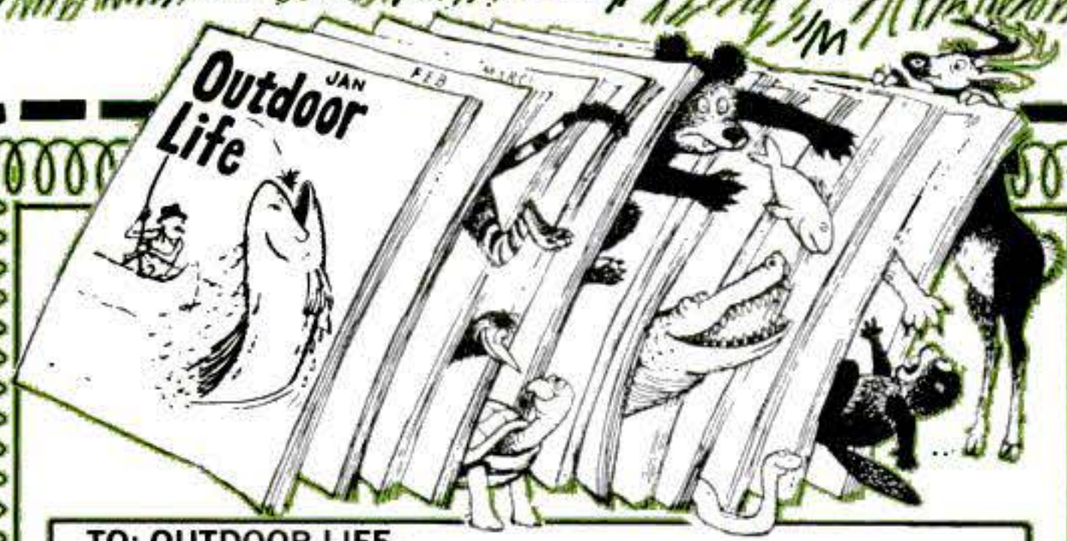

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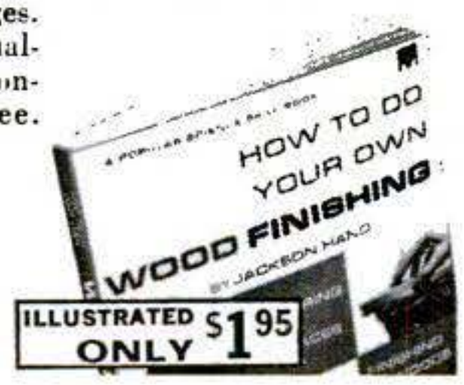

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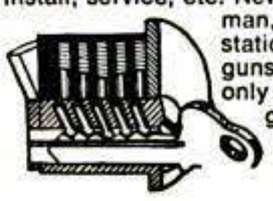

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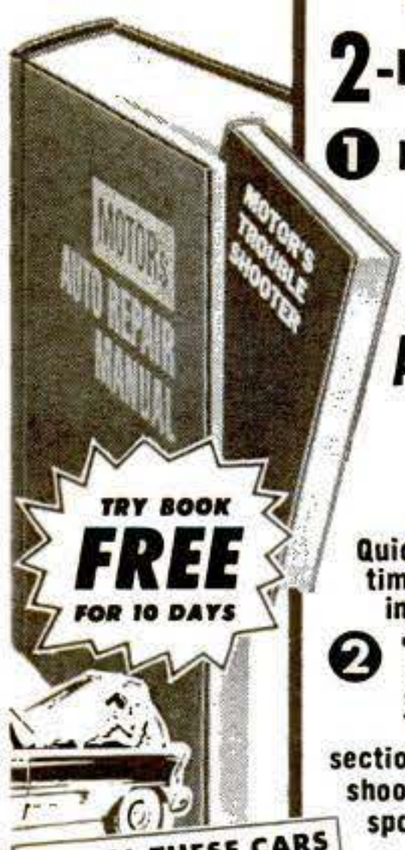

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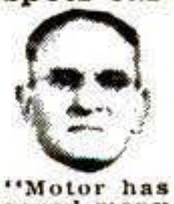

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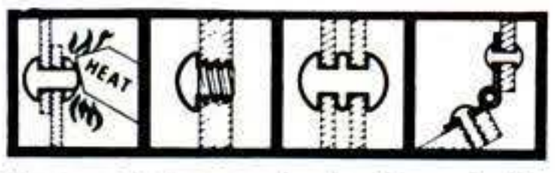

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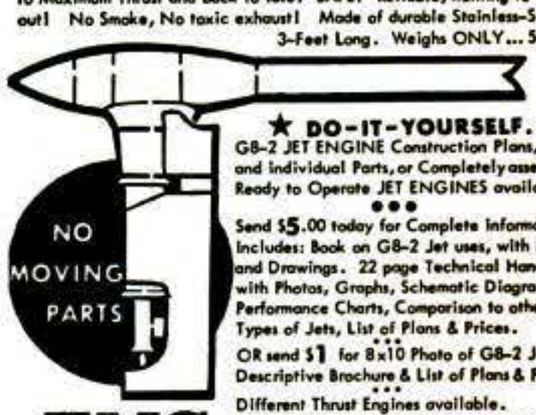

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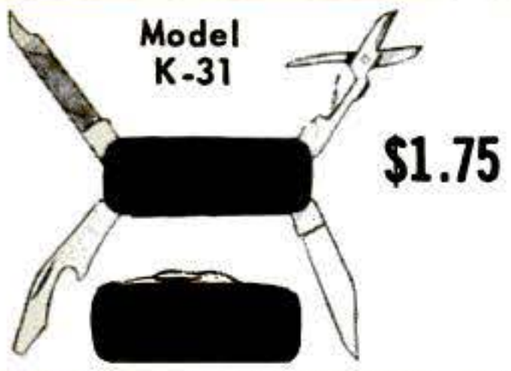

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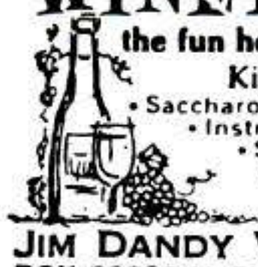

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107 HEARING AIDS

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THIS CAN BE YOUR "BIG BREAK"

if you're a man who's ever said...

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CHRYSLER MOTORS CORPORATION

We build three different wagons exactly the same way. With plenty of room.

Plymouth Satellite Regent

Plymouth Sport Suburban

Chrysler Town & Country

You see, we know everyone buys a wagon for the same basic reason. Room.

That's why every one of these wagons has room enough for 4′ x 8′ plywood sheets laid flat, with the tailgate closed.

And it's easy to use that huge cargo space because every one of these wagons comes with a 3-way tailgate. It opens down for things. Out for people. It even opens out with the glass up.

All these wagons offer 3-seat models, too. In case you want to use that extra room for people instead of cargo.

And these wagons all offer an integrated air deflector to help keep dust off the rear window.

Then, if our wagons are so much alike, why do we build three different wagons?

Well, while everyone has the same needs in a wagon, not everyone has the same wants in a wagon.

So we build a Satellite wagon. A Fury wagon. And a Chrysler wagon.

Our mid-size Satellite wagon gives you plenty of room for knees and elbows. And a very comfortable interior.

If you want even more elbow room, look into our full-size Fury. Fury also has a power-operated tailgate window, standard. Satellite's is optional.

The Chrysler Town & Country is very simply one of the most luxurious wagons you can buy. It comes with simulated wood-grain appliqué on the body sides. Deep loop-pile carpeting covers not only the floor, but the cargo area as well. There's a plush all-vinyl bench seat with a fold-down center armrest. And a big 400 cubic inch V-8.

But whatever Chrysler-Plymouth wagon you get, you can be sure you're getting all the utility you need in a wagon.

CHRYSLER

Plymouth

Coming through with the kind of car America wants.

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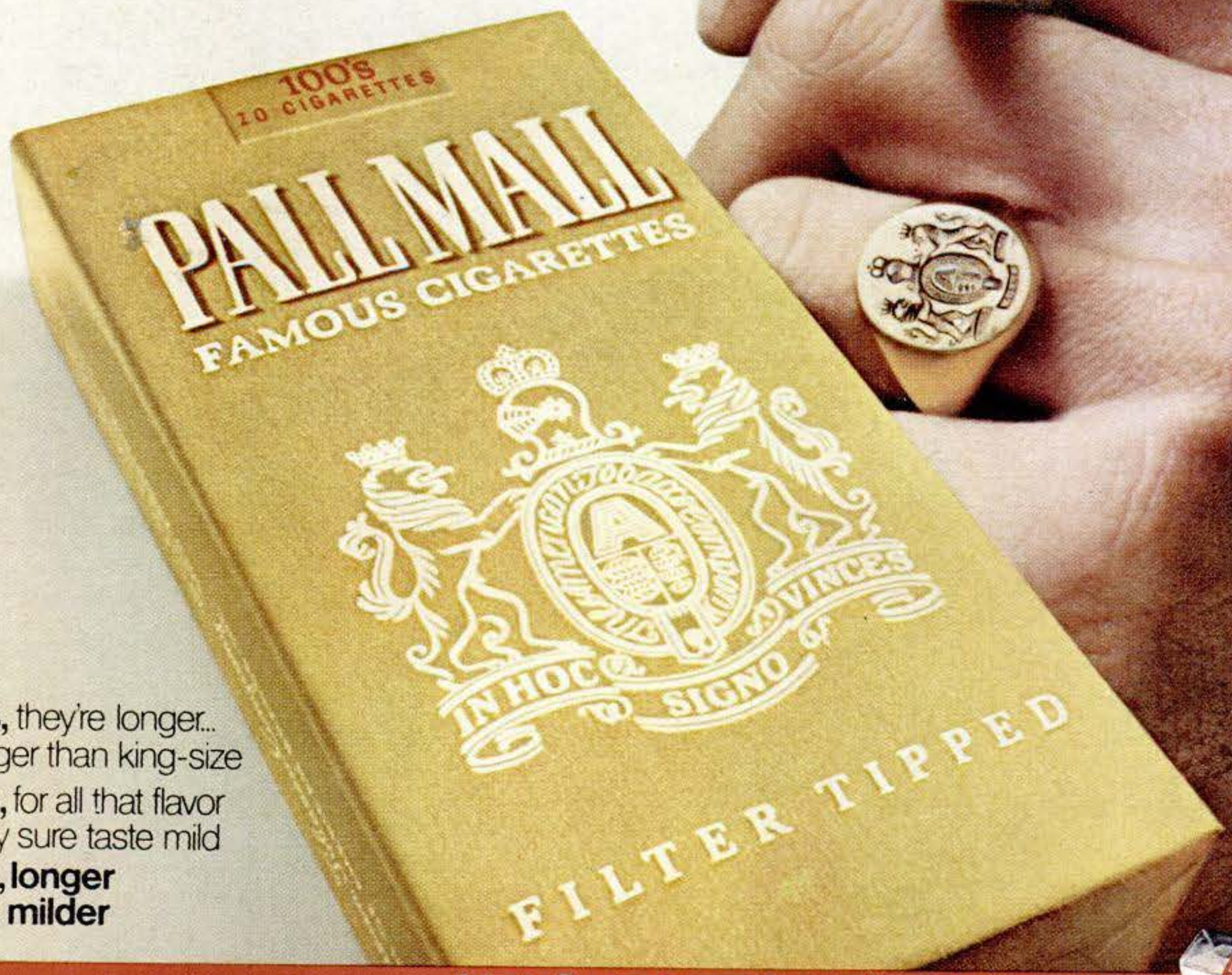
PALL MALL GOLD 100's

Yes, longer yet milder.



Yes, they're longer...
longer than king-size
Yes, for all that flavor
they sure taste mild
Yes, longer
yet milder

Also first class flavor in a filter king
New Pall Mall Filter King

Gold 100's:
19 mg. "tar", 1.3 mg. nicotine av. per cigarette, FTC Report AUG. '71.

20 mg. "tar", 1.4 mg. nicotine av. per cigarette by FTC method.

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